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DRAFT

October 29, 2003
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Mr. Bernie Orenstein
U.S. EPA Region 5
77 West Jackson Boulevard (DM-7J)
Chicago, IL 60604

Subject: EPA Contract No. 68-W-02-018, Work Assignment R05802, Corrective Action Support, Task 2, TDM No. 1. Final Human Health Risk Assessment for Dick's Creek and Tributaries. AK Steel Corporation, Middletown, Ohio.

Dear Mr. Orenstein:

In response to Work Assignment R05802, Task 2, under EPA Contract No. 68-W-02-018, Booz Allen Hamilton has prepared the attached Final Human Health Risk Assessment (HHRA) for Dick's Creek and Tributaries, for the AK Steel, Middletown, TDM. This HHRA evaluates the risks to human health from PCBs in sediments, soils, and fish. The HHRA also includes a forensic "fingerprint" statistical analysis, which is used to identify and compare PCBs detected at AK Steel to those in background areas. The HHRA concludes that PCB releases from the AK Steel facility have resulted in high levels of PCB contamination, which results in a high human health risk for individuals using Dick's Creek and its tributaries.

If you have any questions regarding this deliverable, please contact me at (703) 902-5503 or Phebe Davol at (254) 753-3419.

Sincerely,

Katie Thompson

BOOZ ALLEN HAMILTON INC. (For)

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HUMAN HEALTH RISK ASSESSMENT FOR DICK'S CREEK AND TRIBUTARIES

AK STEEL
MIDDLETOWN, OHIO

Prepared for:

U.S. Environmental Protection Agency
Region 5
Waste, Pesticides and Toxic Division
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EXECUTIVE SUMMARY

A human health risk and toxicological evaluation for Monroe Ditch, Dick's Creek, and its tributaries was conducted to quantify the risk of developing cancer associated with exposure to AK Steel's uncontrolled releases of polychlorinated biphenyls (PCBs). Cancer risks associated with exposure to contaminated sediments, soils, and fish were quantified to determine whether the contaminant levels pose a public health risk to the people in the community. A forensic "fingerprint" statistical analysis was also conducted to identify and compare the weathered PCB mixtures detected in Monroe Ditch and Dick's Creek to the fingerprint of PCBs present in background or reference areas. Additionally, the fingerprint analysis was used to determine whether "third-party releases" of PCBs have occurred, as has been suggested by AK Steel. Based on the results from this study it can be concluded that:

- Uncontrolled releases of PCBs from the AK Steel facility have contaminated sediments, floodplain soils, and fish in Monroe Ditch and Dick's Creek;
- The volume of PCBs released from the AK Steel facility has resulted in highly contaminated sediments, floodplain soils, and fish, posing a significant threat to public health;
- The PCBs that have been released from the AK steel facility contain high levels of a particular group of highly toxic "dioxin-like" PCBs;
- Exposure to PCB contamination in sediments, soils, and fish for nearby residents using Dick's Creek for recreational purposes poses unacceptable cancer risk and other potential toxicological effects;
- The cancer risk for the reasonable maximum exposed (RME) individual exceeds 1E-3 (a 1-in-1,000 risk);
- Cancer risks and toxicological effects associated with PCB exposure are likely even higher for sensitive subpopulations, including pregnant women (or women of childbearing age), those taking some medications, and those suffering from immunosuppression;
- AK Steel is solely responsible for the PCB releases detected in Monroe Ditch and Dick's Creek from sample location S17 to the Excello Trailer Park. There is no evidence of a "third-party" release of PCBs upstream of the Excello Trailer Park.

1. INTRODUCTION

This document presents the human health risk assessment (HHRA), background analysis, and forensic fingerprint investigation conducted by Dr. Richard DeGrandchamp for the AK Steel, Middletown Works facility (AK Steel). This study is based on the most recent PCB congener sampling and analysis investigation carried out by USEPA. Although numerous previous samples have been collected and evaluated primarily with "Aroclor" analysis to determine the nature and extent of releases, USEPA has more recently conducted a much more sophisticated study to gauge the extent of PCB contamination based on the individual PCB congener composition. These data provided the necessary information to:

1. Quantify cancer risks associated with exposure to dioxin-like PCB congeners; and
2. Conduct a forensic fingerprint analysis to determine if AK Steel is responsible for all or some of the PCB releases in Monroe Ditch and Dick's Creek.

According to USEPA (1996) guidance (*PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures. Office of Research and Development*), as well as the more recent National Academy of Sciences, National Research Council, scientific recommendations presented in *A Risk-Management Strategy for PCB-Contaminated Sediments*, PCB congener analysis should be performed at PCB-contaminated sites where Aroclors released into the environment may have undergone significant weathering. This is because Aroclor analysis can misrepresent contaminant conditions. Furthermore, PCB congener data provides the necessary information to conduct sophisticated fingerprint analyses to determine responsibility for the release.

Verifiable environmental data for the most toxic constituents—namely, the PCB dioxin-like congeners—have been lacking. This is important because the carcinogenic potency (based on USEPA's slope factors) for some of the dioxin-like PCB congeners is more than a thousand-times greater than non-dioxin-like PCBs. In addition, USEPA guidance states that Aroclor data should not be used to quantify PCB-related risks at sites where PCBs have undergone weathering because PCB contamination can go undetected, even though they may be present in high concentrations. The present study shows that this has been the case for the AK Steel site. That is, the most recent sampling and analysis directly comparing Aroclor and PCB congener analytical data show that Aroclor analysis has likely underestimated the total PCB contamination.

2. HUMAN HEALTH RISK ASSESSMENT

2.1 BACKGROUND

The goal of this HHRA is to quantify potential current and future risks to human health associated with exposures to uncontrolled releases of PCBs in Dick's Creek and its tributaries. These contaminant releases have been historically attributed to the AK Steel facility. However, until recently, the environmental data have not been available to prove unequivocally that the AK Steel facility is the source of PCB contamination in Monroe Ditch and Dick's Creek. The newly collected data provide precisely the information regarding the source and responsibility of PCB contamination that was previously lacking to accurately determine not only the human health risks, but also the contaminant source, through a detailed fingerprint analysis. Comparing fingerprints of the PCBs detected downstream from the AK Steel property (starting at sample location S17) with those representing "anthropogenic" background conditions in the region proves that the AK Steel facility is the one and only significant source of PCBs in sediments and floodplain soils in Monroe Ditch and Dick's Creek.

The cancer risks presented in this HHRA are based on current and hypothetical future exposure conditions in the absence of remediation efforts or institutional controls to prevent exposure. It is particularly important to assume the institutional controls suggested by AK Steel will not control exposures because PCBs are extremely persistent and because the facility cannot control exposures in the contaminated off-site properties. Additionally, there is no legal mechanism for controlling exposures in Dick's Creek and Monroe Ditch.

It is important to stress that institutional controls to prevent exposures must be permanent and protect against human exposure until the concentrations of the contaminants naturally degrade to health-protective levels through natural attenuation. This period for PCBs will be on the order of several decades because natural attenuation for PCBs is extremely slow; PCBs will attenuate to health protective levels in the creek and ditches only after a long period of time. That is, PCBs are among the most persistent contaminants ever studied.

Therefore, institutional controls should not be considered either a temporary or permanent solution for protecting public health. With persistent contaminants, which include all PCB—but, most importantly, the dioxin-like PCBs—institutional controls should not be evaluated as part of any human health risk assessment.

USEPA (1991b) guidance clearly states:

> *"The cumulative site baseline risk should include all media that the reasonable maximum exposure scenario indicates are appropriate to combine and should not assume that institutional controls or fences will account for risk reduction."*

USEPA (1989) states:

> *"Part of the human health evaluation, the baseline risk assessment (Part A of this manual) is an analysis of the potential adverse health effects (current or future) caused by hazardous substance releases from a site in the absence of any actions to control or mitigate these releases (i.e., under an assumption of no action)."*

Lastly, institutional controls cannot be legally enforced at any part of Dick's Creek, particularly to prevent recreational fishing. Indeed, despite the common knowledge that the Dick's Creek is contaminated with PCBs, fishing is an ongoing recreational activity.

This HHRA is organized into the following sections:

- Site Characterization;
- Data Evaluation and Estimating Exposure Point Concentrations;
- Exposure Assessment;
- Toxicity Assessment;
- Risk Characterization; and
- Uncertainty Assessment.

It should be noted that the risk assessment methodology for PCB-contaminated sites is different from the conventional approach used at most non-PCB contaminated sites. At those sites, risks for chemicals are individually estimated and simply summed. In contrast, adjustments in the scientific paradigm must be made for PCB contaminated sites to account for PCB weathering and environmental partitioning, preferential bioaccumulation in fish, and the complexity and persistence of environmental PCB mixtures. USEPA (1996) PCB risk assessment guidance for PCBs requires a tiered approach in which risks are estimated based on total PCB concentration, as well as on the amount of individual dioxin-like PCB congeners detected.

PCBs are manmade, highly complex mixtures of 209 individual congeners. Each of these congeners has a distinct chemical property and inherent toxicity that is based on the number and placement of chlorine atoms on a biphenyl ring and the physical configuration of the biphenyl ring. The term "Aroclor" refers to the trademark commercial mixtures made up of varying amounts of these different congeners in the *original* mixture.

All PCB congeners released into the environment will partition into different environmental media (water, soil, air, animals, etc.) based on the chemical properties of each *congener.* Consequently, USEPA guidance (1996) specifically requires the use of three different toxicity values, or slope factors, for total PCBs, which are based on the particular *environmental media* PCBs have contaminated and specific *exposure routes.* This is in contrast to simply using the Aroclor data (e.g., A1248, A1260), which can provide misleading information about the degree of contamination at sites where the original PCB mixtures have undergone weathering.

2.2 SITE CHARACTERIZATION

Until recently, PCB contamination in Dick's Creek and its tributaries has been primarily characterized with Aroclor analysis (with some samples being analyzed for PCB homologs). However, the most recent sampling and analysis has been conducted to determine the extent of contamination by PCB congeners, with particular emphasis on the small, but highly toxic, dioxin-like PCB fraction. For purposes of characterizing the nature and extent of contamination and quantifying cancer risks at PCB weathered sites, PCB congener data is far superior to Aroclor data (which can significantly underestimate risks) and was used exclusively to characterize contamination in Dick's Creek and Monroe Ditch.

The first step in evaluating PCB exposures in the HHRA is to develop a conceptual site model (CSM). For a HHRA, it forms the basis for determining the magnitude of contaminant exposure for an individual who uses the site for recreational purposes in order to quantify the dose of PCBs. Most important in estimating the dose is how much and how long a person comes into contact with contaminated sediments, soils, and fish, and the physical area over which that exposure is currently occurring or is reasonably expected to occur on a routine basis in the future, for the same individual or population. The CSM is based on all physical aspects of the site, which are coupled to well-designed studies on human activity patterns, particularly those involving human recreation.

The area over which an individual spends the majority of his or her time engaged in recreational activities along Dick's Creek is termed the "exposure unit" or "exposure area." This unit is simply defined as the geographical area where an individual will repeatedly come into contact with contaminated environmental media. This is the foundation upon which data are pooled, or aggregated, to estimate the contaminant dose. The size of the exposure unit is dependent on the site and type of activities expected at the site. For example, in determining the area for residential exposures, USEPA (1989) guidance states:

> *"The area over which the activity is expected to occur should be considered when averaging the monitoring data for a hot spot. For example, averaging soil data over an area the size of a residential backyard (e.g., an eighth of an acre) may be most appropriate for evaluating residential soil pathways."*

Likewise, for a recreational exposure, it is reasonable to assume, based on studies of human activity patterns during recreation, that individuals who frequent Dick's Creek and its tributaries for recreation will find a favorite spot and habitually return to the same location. In contrast, it is unreasonable to assume that an individual will be exposed to the entire length of Dick's Creek and its tributaries during routine daily exposures. Consequently, to estimate the average daily dose of contaminants, data must be aggregated over the area where exposure is expected to occur for an individual.

Toxicologists determine the daily chemical dose—or, in this case, the contaminant dose—based on the representative PCB concentration within the defined exposure unit. The exposure point concentration (EPC) is the chemical dose that is directly dependent on the size of the exposure unit and the sampling design. Based on an extensive review of AK Steel documents and a site visit, the reasonable river length representing exposure for an individual is somewhere between the two. While it is plausible a jogger or hiker could be exposed to the entire length of the river, a jogger is not the type of individual for which this HHRA is based. Averaging the exposure over the entire length is not appropriate for estimating the daily dose for an individual engaged in more typical recreational activities such as hiking and fishing. In contrast, focusing on too small an area has the potential of overestimating risks by focusing on unreasonably small areas.

The receptors currently exposed and who are expected to be exposed in the future are similar to those visually identified at Dick's Creek by USEPA Region 5 and Ohio EPA personnel. Children, adolescents (particularly school children), and adults have been directly observed in a variety of recreational activities in and around Dick's Creek. Furthermore, evidence of some of these activities was observed during the site visit, including a tire swing along the Dick's Creek river bank near Amanda School and a plastic bag of caught and discarded fish along a well-traveled hiking path paralleling the river. There is little question that nearby residents spend considerable time along most stretches of Dick's Creek and its tributaries.

Based on this information and careful evaluation during the site visit Dr. DeGrandchamp conducted, it was determined that three discrete exposure areas along Dick's Creek should be re-sampled using precise PCB congener analysis. The resulting PCB congener data were then combined, or aggregated, for three discreet river segments. It should be stressed that the data were aggregated for purposes of developing the CSM for the HHRA and have no regulatory basis. The CSM is only intended to represent potential exposures; for this reason, Dick's Creek and Monroe Ditch were partitioned into 2 segments—namely, Areas of Concern 1 and 2 (AOC-1 and AOC-2). The following descriptions present the data that were aggregated to represent either exposure conditions for risk assessment purposes or fingerprint analyses to determine responsibility for the contamination in Monroe Ditch and Dick's Creek.

- ***Background Area*** - All samples collected in Dick's Creek and its tributaries upstream from sample location S17 (approximate river mile 2.9). This area provides the necessary data to establish the forensic fingerprint for comparison to the fingerprint for all samples collected downstream sample location S17 (which is the contaminated segment of Dick's Creek and Monroe Ditch). The PCB fingerprint developed for this upstream background area will serve as a reference area representing anthropogenic background conditions. Differences between the PCB fingerprint for the background area and the samples collected downstream from sample location S17 indicate uncontrolled releases of PCBs have come directly from the AK Steel facility. It should be noted that in the fingerprint analysis, presented in Appendix A, the background fingerprint was compared with the fingerprint based on all samples (combining AOC-1 and AOC-2) collected from sample location S17 downstream to the Excello Trailer Park.

- ***Exposure Area of Concern-1 (AOC-1)*** - AOC-1 is defined as the segment of Dick's Creek starting at the 2.5 river mile point (demarcated by sample location S23) near Yankee Road downstream to the Excello Trailer Park at approximate river mile 0.9 (demarcated by sample location S30).
- ***Exposure Area of Concern-2 (AOC-2)*** - AOC-2 is defined as Dick's Creek from sample location S17 downstream to a point approximately 1/16 mile downstream of Yankee Road at approximate river mile 2.5 (demarcated by sample location S23).

Based on a careful review of the recent PCB congener and Aroclor sampling data in which recent data were compared with archival Aroclor data (used in previous risk assessments), it was determined that the current HHRA would be more scientifically tenable if it were based only on the results of the recent PCB congener sampling and analysis. This decision was based on a direct comparison of PCB congener data with Aroclor data from the same sample, which indicated Aroclor analyses at the site misrepresent contaminant concentrations. Consequently, it would be inappropriate to pool data from archival data sets with recent sampling for the HHRA. A summary of the rationale for this decision is as follows:

- Aroclor analysis underestimates PCB contamination (as will be shown in subsequent sections);
- Recent data better represent the current "snapshot" of contaminant conditions and the extent to which PCB has migrated downstream;
- There is no archival PCB congener data (with the exception of several limited and unverifiable WSU data);
- Pooling Aroclor (and homolog) data and PCB congener data would increase the variability of data sets and introduce unnecessary variability;
- PCB congener data provide far superior toxicological information to evaluate the threat to public health compared with Aroclor data;
- PCB congener data were deemed sufficient to represent exposure conditions along Dick's Creek, making archival Aroclor data superfluous;
- Aroclor data are unreliable for fingerprinting the type of complex environmental PCB mixtures (that have undergone extensive weathering) at the AK Steel facility and do not provide useful information in determining who is responsible for releasing PCBs into Dick's Creek.

The following sections present the PCB congener data sets that were used in this HHRA.

2.3 DATA EVALUATION AND ESTIMATING EXPOSURE POINT CONCENTRATIONS

Background

PCBs are complex mixtures of chlorinated organic chemicals that were specifically manufactured for their insulating properties and have historically been used in capacitors, transformers, and other electrical equipment. Commercial PCB mixtures synthesized in the United States were trademarked "Aroclor." Aroclors were formulated to have similar physical properties, rather than similar composition, to those of individual PCB compounds. Thus, Aroclor mixtures of the same type can vary in composition. Depending on conditions of their synthesis, the degree of chlorination can vary between 21% and 68% on a weight-percentage basis. U.S. companies that manufactured Aroclors (e.g., Monsanto) developed a numbering system to identify various mixtures. With the exception of Aroclor A1016, Aroclors are numbered with a four-digit code in which the first two digits are 12 and the last two digits represent the percentage by weight of chlorine. For example, Aroclor 1260 is a mixture that contains 60% chlorine by weight. Aroclor analysis, which is largely based on this information, is conducted according to USEPA Method 8082.

Although data and information on commercial Aroclors are important because the uncontrolled releases of PCBs at AK Steel are presumed to have been Aroclors, the composition of PCB mixtures contaminating Dick's Creek have undergone marked transformation. These transformations are termed "weathering," which can lead to increased or decreased toxicity of the environmental mixture detected in AK Steel samples.

Each Aroclor is a mixture of individual compounds called PCB congeners. Although there are 209 theoretically different and individual PCB congeners, only about 130 are likely to exist in Aroclor mixtures (Safe 1990). While the concentration of Aroclors in environmental samples can provide useful information in determining the nature and extent of contamination at a hazardous waste site, the overall toxicity of environmental PCB mixtures is the sum of the individual toxicity of each PCB congener present in the mixture, which can only be derived by knowing the concentration of each congener. Environmental weathering can dramatically alter the PCB congener composition of commercial Aroclors released into the environment and, consequently, their toxicity. Therefore, to evaluate the toxicity and health risks associated with weathered environmental mixtures, the composition and concentration of individual PCB congeners must be quantified.

Non-ortho and mono-ortho chlorinated PCB congeners can assume a flat planar configuration similar to that of the rigidly planar chlorinated dioxins and furans, eliciting an identical toxic response. Thus, the group of 12 coplanar PCBs that are present in some Aroclors are referred to as dioxin-like PCBs and pose significantly greater toxicity and health risks compared with non-dioxin-like PCBs. The exact positions of chlorine bound to the biphenyl ring govern binding to a specific receptor in mammalian cells and, hence, the toxicity. Of most importance are positions 2, 6, 2', and 6', which are the carbons nearest the bond between phenyl rings and are referred to as "ortho" positions (positions 3, 5, 3', and 5' are meta positions, while 4 and 4' are para positions). Chlorinated ortho positions are important because they prevent coplanar alignment similar to that of the dioxins and furans.

The toxicity of dioxin-like PCBs are totally ignored when using Aroclor data. This is despite a *priori* knowledge that commercial mixtures of Aroclors are composed of a significant fraction of dioxin-like PCBs. For example, Frame *et al.* (1996) determined the amount of dioxin-like PCBs in commercial Aroclor mixtures. The results of their studies are presented in Exhibit 1. As indicated, the concentrations of the 12 dioxin-like PCB congeners can range from 1.5% to 24% in commercial mixtures. Although dioxin-like PCB congeners represent only a small percentage of the overall Aroclor, they are much more potent toxicologically than are non-dioxin like PCB congeners (some are 1,000 times more toxic). In fact, the overall toxicity of Aroclors is largely dependent on the presence of dioxin-like PCB congeners in the mixture. However, the composition of dioxin-like PCBs is relative and can change dramatically in environmental mixtures and in preferential bioaccumulation.

EXHIBIT 1

DIOXIN-LIKE PCB CONGENER CONCENTRATIONS IN COMMERCIAL AROCLOR MIXTURES

DIOXIN-LIKE PCB CONGENER	WEIGHT PERCENT OF DIOXIN-LIKE PCBS IN DIFFERENT COMMERCIAL AROCLORS					
	A1242	A1248	A1248	A1254	A1254	A1260
PCB77	3.1E-01	4.1E-01	5.2E-01	2.0E-01	2.8E-02	
PCB-81	1.1E-02	1.4E-02	2.0E-02	2.9E-03		
PCB-105	4.7E-01	1.6E+00	1.5E+00	7.4E+00	3.0E+00	2.2E-01
PCB-114	4.0E-02	1.2E-01	1.2E-01	5.0E-01	1.8E-01	
PCB-118	6.6E-01	2.3E+00	2.3E+00	1.4E+01	7.4E+00	4.8E-01
PCB-123	2.7E-02	7.0E-02	8.0E-02	3.2E-01	1.5E-01	
PCB-126		3.7E-03	2.9E-03	1.6E-02	1.7E-03	
PCB-156	7.2E-03	5.7E-02	3.6E-02	1.1E+00	8.2E-01	5.2E-01
PCB-157		9.2E-03	4.5E-03	3.0E-01	1.9E-01	1.9E-02
PCB-167		8.8E-03	7.5E-03	3.5E-01	2.7E-01	1.9E-01
PCB-169						
PCB-189				9.1E-03	1.1E-02	1.0E-01
WEIGHT PERCENT	1.5	4.6	4.6	24.0	12	1.5

Source: Frame *et al.* 1996.

As discussed, numerous environmental samples have been collected in surface water, sediments, soil, and fish from Dick's Creek and its tributaries over the years. With few exceptions (those in which samples have been analyzed for PCB homolog groups), samples have been analyzed with USEPA Method 8082 to estimate the amount of Aroclor in a particular sample. This is despite USEPA guidance (USEPA 1996) that strongly urges that Aroclor data *not* be used to quantify PCB-related human health risks. Aroclor analysis yields data that can lead to underestimating human health risks at hazardous waste sites because of the following three flaws inherent in Aroclor analyses:

- PCB contamination can go completely undetected in a sample if the PCB mixture is highly weathered due to the absence of characteristic peaks that are used to positively confirm that the sample contains a particular Aroclor;
- The total PCB concentration can be underestimated because only a subset of characteristic peaks is quantified; and
- Aroclor data in fish tissue (as well as in other biological receptors) underestimate human health risks associated with eating PCB-laden fish because the 12 most toxic dioxin-like PCB congeners are preferentially bioaccumulated (relative to the other PCB congeners), and the overall toxicity is not accurately represented by Aroclor data.

It is often mistakenly thought that use of Aroclor data can overestimate the total PCB concentration if individual PCB congeners are "double counted" because individual congeners may be present in more than one Aroclor reported in a sample. In reality, this is rarely the case; in fact, at the AK Steel facility, the converse is true. Environmental samples of PCB mixtures that have undergone weathering can be transformed from the original Aroclor mixture released into the environment and make it appear as though *no* Aroclor is present when, in fact, PCB congeners *are* present. PCB congeners may be present at high concentrations in these "non-detect" Aroclor samples. This is because when samples are analyzed for "Aroclors," the analysis and identification of Aroclors is based on the presence of a characteristic, but limited, subset of PCB congeners that are considered a "fingerprint"of the original Aroclor mixture. With Aroclor analysis, a non-detect for Aroclors is simply translated into non-detect for PCBs. This flaw in Aroclor analysis can be compounded when the PCB congeners are present but overlooked.

When weathering occurs, some individual congeners are degraded or have partitioned into other environmental media. This concept is explicitly stated in USEPA PCB risk assessment guidance (USEPA 1996):

"Although environmental mixtures are often characterized in terms of Aroclors, this can be both imprecise and inappropriate. Qualitative and quantitative errors can arise from judgments in interpreting gas chromatography/mass spectrometry (GC/MS), which reveals a spectrum of peaks that are compared with characteristic patterns for different Aroclors. For environmentally altered mixtures, an absence of these characteristic patterns can suggest the absence of Aroclors, even though some congeners are present in high concentrations."

As is also noted in the USEPA IRIS file for PCBs (USEPA 2003), congener analysis is important for the assessment of human health risks posed by a site:

"Although PCB exposures are often characterized in terms of Aroclors, this can be both imprecise and inappropriate. Total PCBs or congener or isomer analyses are recommended."

It should also be noted that both weathering and bioaccumulation into biological tissues can result in profound changes in the composition of PCB environmental mixtures that can increase the toxicity of the mixture if based on Aroclor analysis. This is because weathering can result in selective degradation of more water soluble, less toxic PCB congeners (increasing the relative amount of dioxin-like PCB congeners), while preferential bioaccumulation of the subset of dioxin-like PCB congeners in fish can cause the *relative* concentration of dioxin-like PCBs to increase. USEPA discusses these phenomena in its PCB guidance (USEPA 1996) :

"Unfortunately, the environmental weathering of Aroclors modulates mixture toxicity (Quensen et al. *1998). As such, carcinogenic risk-assessment guidelines recommend the calculation of congener-specific or total PCB data when available (EPA 1994c). Congener-specific analyses utilize the direct quantification of each unique PCB congener. The result is a precise description of PCB profiles, which can highlight physiological, spatial, and temporal changes that might not be apparent in Aroclor values....Individual congener data provides the most flexibility for supporting environmental management decisions, because the congeners provide the raw data that can be analyzed numerically or statistically by the environmental manager, case by case, as needed....*

Congener-specific analysis is recommended for risk assessment because of the differences in the toxic potentials of individual congeners in technical mixtures."

Recent PCB Congener Sampling and Analysis

As previously noted, USEPA Region 5 recently supplemented the existing Aroclor data sets by collecting additional sediment, floodplain soil, and fish samples in Dick's Creek and its tributaries. Each sample was analyzed for Aroclors using USEPA Method 8082 and for the 209 PCB congeners using USEPA Method 1668. In addition to the aforementioned advantages of the PCB congener analysis, the dual analyses of Aroclors and PCB congeners allowed a direct sample-by-sample comparison to determine whether Aroclor analysis underestimates PCB contamination in samples and provides support for this bias in archival data sets.

In addition to the Aroclor and PCB congener analysis, each sample was also analyzed for dioxin and dibenzofuran congeners (furans), according to USEPA Method 1613. This analysis was conducted because: (1) dioxins are frequent co-contaminants at PCB hazardous waste sites; and (2) furan congeners are released as part of the uncontrolled release of Aroclors because they are present as contaminants in commercial Aroclor mixtures. Exhibit 2 shows the results from studies in which furan concentrations were measured in different commercial Aroclor mixtures.

EXHIBIT 2
DIBENZOFURAN CONGENERS IN COMMERCIAL AROCLOR MIXTURES

	CONCENTRATION OF CHLORINATED DIBENZOFURANS (CDFs) IN AROCLOR MIXTURES			
	Furans With 4 Chlorines	Furans With 5 Chlorines	Furans With 6 Chlorines	Total Furans
A1248	0.5 (25)	1.2 (60)	0.3 (15)	2.0
A1254	0.1 (6)	0.2 (12)	1.4 (82)	1.7
A1254	0.2 (13)	0.4 (27)	0.9 (60)	1.5
A1260	0.1 (10)	0.4 (40)	0.5 (50)	1.0
A1260	0.2 (25)	0.2 (38)	0.3 (38)	0.8

Notes: Values expressed as mg CDBF/kg PCB mixture. Values in parentheses represent the percentage of total CDBFs.

Source: WHO 1993

With the addition of the recent supplemental PCB sampling based on PCB congener analysis, there is now a comprehensive PCB data set representing contamination in Dick's Creek and its tributaries. A thorough and detailed HHRA and toxicological evaluation can now be conducted with minimal uncertainty. Indeed, based on comparison of the Aroclor data (historically used to characterize the nature and extent of contamination and potential human health risks) with the newly generated PCB congener data, it can be concluded that the extent of PCB contamination and concomitant risks to public health have thus far been underestimated.

Sampling Locations

Exhibit 3 presents the sampling locations for sediment and floodplain soils recently collected and analyzed for dioxin-like PCBs, Aroclors, dioxins, and furan congeners. Each sample was analyzed for each of the four groups to determine the sample concentration and to evaluate the appropriateness of Aroclor analysis. As presented in Exhibit 3 and previously described, samples representing AK Steel releases were collected from areas downstream of sample location S17 and background or reference samples upstream from sample location 17. Several samples were duplicates whose analysis showed consistent analytical results indicating the data quality is relatively high. Exhibit 4 shows a map of sampling locations. Exhibit 5 presents the locations were fish were caught, as well as the types of fish caught in each location.

EXHIBIT 3
LOCATION OF SEDIMENT AND FLOODPLAIN SOIL SAMPLING LOCATIONS

Station Sample No.	Sampling Locations	River Mile	AOC
AK STEEL AOC SAMPLES			
03CM01S43	MD, Near mouth, 8-14" depth of S10 cores	0.01	1
03CM01S10	MD, Near mouth, top 8" of each core	0.01	1
03CM01S11	MD 150' downstream of treatment system	0.35	1
03CM01D33	Duplicate of S11	0.35	1
03CM01S01	DC, N. Side, W. of Main St., about 100'	0.90	1
03CM01S03	DC, N. Side, Amanda School #1 (west)	1.63	1
03CM01S04	DC, N. Side, Amanda School #2	1.70	1
03CM01S05	DC, N. Side, Amanda School #3 (east)	1.87	1
03CM01S06	DC, Upstm. of Unnamed Trib. (Tree swing)	2.00	1
03CM01S07	DC, N. Side, Near USGS	2.45	2
03CM01S08	DC, Upstream Yankee Road #1 (Orman's)	2.55	2
03CM01S31	DC, N. Side, Opp. Orman's, Upstm. Yankee	2.58	2
03CM01S09	DC, Upstream Yankee Road #2 (Orman's)	2.64	2
03CM01S12	DC, Upstm. MD #1, about 300' E., N. bank	2.76	2
03CM01D42	Duplicate of S13	2.81	2
03CM01S13	DC, Upstream MD #2, about 100' E. of S12	2.81	2
03CM01S14	Outfall Channel 002	2.92	2
03CM01S15	DC, N. Side, Upstream Outfall 002 #1	3.03	2
03CM01S16	DC, N. Side, Upstream Outfall 002 #2	3.35	2
03CM01S17	DC, about 100 yards downstream Outfall 003	3.5	2
FLOODPLAIN SAMPLES			
03CM01S30	Outfall ditch @ Simpson Paper (0-8")	0.85	1
03CM01S27	Excello (0-8")	1.0	1
03CM01S22	Near Amanda School (Geoprobe) (top 14")	1.78	1
03CM01D32	Duplicate of S22	1.78	1
03CM01S23	Near USGS station, north side DC (Geoprobe)	2.45	2
03CM01S24	Orman's, Upstm. Yankee Rd #1 (0-8")	2.58	2
03CM01S28	S25 location, deep core (36-43")	2.65	2
03CM01S25	Orman's, Upstm. Yankee Rd #2 (0-8")	2.65	2
03CM01S29	Outside fence @ Art's Parts (0-8")	2.68	2
03CM01S26	N of Monroe Ditch (0-8")	2.72	2
BACKGROUND SAMPLES		RIVER MILE	
03CM01S20	Upstream on Shaker Creek	0.2	
03CM01S21	NBDC, Upstream Outfall 004	0.5	
03CM01S18	DC, about 100' E. of RR bridge, upstm. 015	4.53	
03CM01S19	DC, N. Side, Upstm. Cincinnati-Dayton Road	5.48	

EXHIBIT 4 - MAP SHOWING SAMPLING LOCATIONS FOR AOC-1, AOC-2, AND BACKGROUND

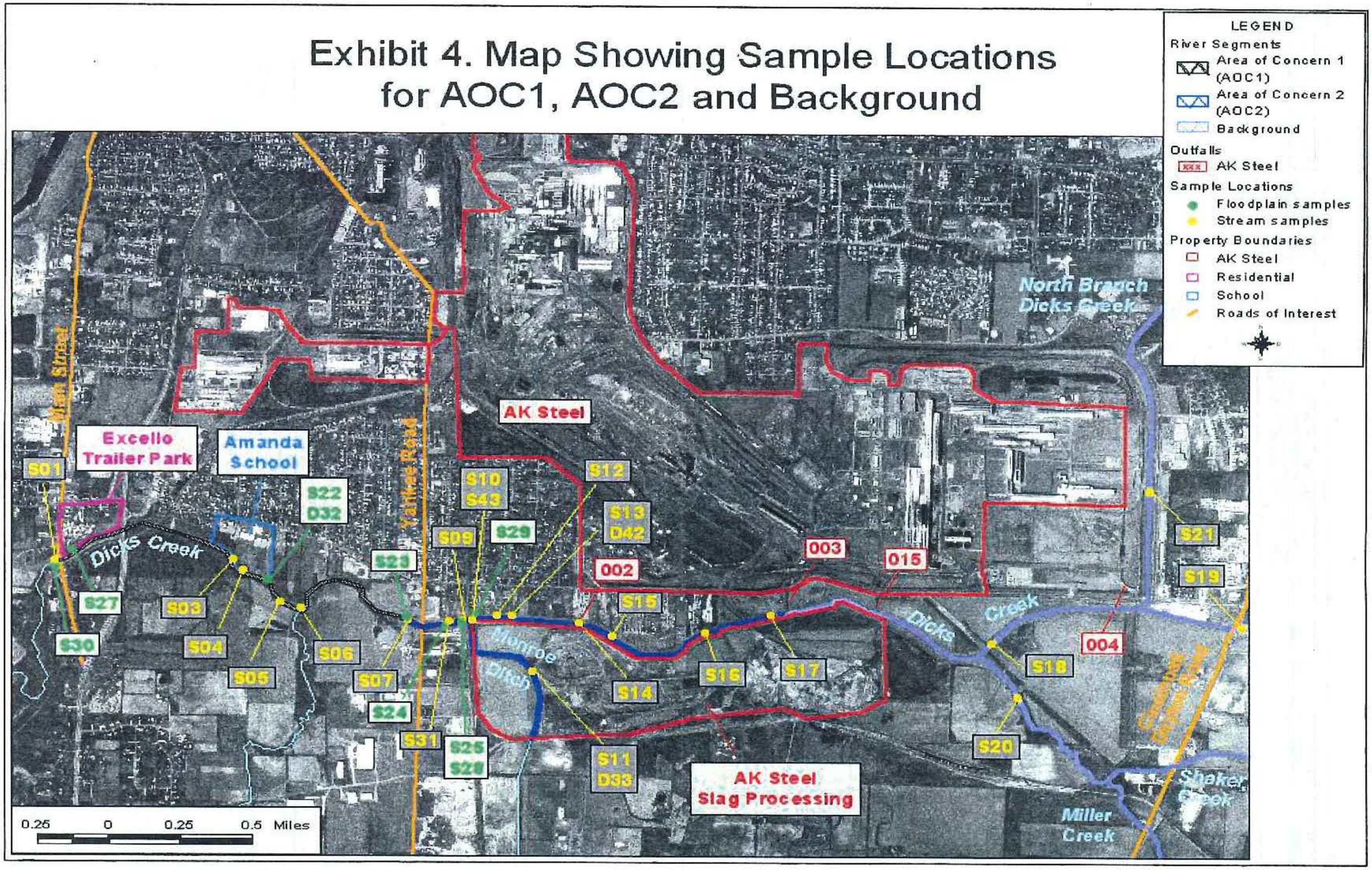


EXHIBIT 5
LOCATIONS WHERE FISH WERE CAUGHT

Fish Sample Number	Type of Fish	River Mile Caught
AOC-1		
258-2002/FT001	Channel Catfish	1.7
258-2002/FT002	Flathead Catfish	1.7
258-2002/FT003	Common Carp	1.7
258-2002/FT004	Smallmouth Bass	1.7
AOC-2		
258-2002/FT005	Channel Catfish	2.5
258-2002/FT006	Channel Catfish	2.5
258-2002/FT007	Common Carp	2.5
258-2002/FT008	Smallmouth Bass	2.8
258-2002/FT009	Common Carp	2.8
258-2002/FT010	Channel Catfish	2.8

Analytical Results

According to NRC (2001) "component based analysis has improved the quality and the toxicological relevance of the resulting data.... Likewise, congener profiles differing from the original technical mixtures in profile and toxicity because of weathering can now be addresses effectively." PCB congener data not only provide information about the content of individual congeners, but also provide the most precise estimate of the total PCB concentration. This is because the total PCB concentration is the sum of all PCB congeners in the sample. According to NRC, "Individual congener data provides the most flexibility for supporting environmental decisions, because the congeners provide the raw data that can be analyzed numerically or statistically by the environmental manager, case by case, as needed."

Evaluating dioxin-like PCB congener data in an HHRA involves assigning congener-specific TEFs to each of the 12 PCB congeners. The TEF values developed by Van den Berg *et al.* (1998) have had international endorsement and have been adopted by the World Health Organization (WHO 1997) and USEPA (2003). They are based on the relative toxicity of 2,3,7,8 tetrachloro-dibenzo-p-dioxin (TCDD), which is the archetypical reference standard. TCDD is assigned a TEF of 1.0. As shown in the exhibits, PCB congeners have TEF values ranging from 0.1 to 0.00001. Calculating the toxic equivalency quotient (TEQ) of a mixture of PCB congeners (which is used directly in the HHRA) involves multiplying the concentration of each individual congener by its corresponding TEF, as developed by Van den Berg *et al.* (1998). The sum of the TEQ concentrations for each individual congeners is the total TEQ concentration for a particular sample. It should be noted that PCB-157 co-eluted with PCB-15, so it was deleted from the data set. Only the results from PCB-156 were considered in order to avoid overestimating contamination.

Sediment Analytical Results

The analytical results for dioxin-like PCB congeners and dioxins and furans in sediment and floodplain soils are presented in Exhibits 6 and 7.

EXHIBIT 6

SEDIMENT AND FLOODPLAIN SOIL DIOXIN-LIKE PCB CONCENTRATION AND TEQ

PCB Congener	TEF	SAMPLE CONCENTRATION AND TEQ (ppb)											
		D32		D33		D42		S01		S03		S04	
		Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ
PCB-77	1.0E-04	1.9E+00	1.9E-04	4.9E+00	4.9E-04	4.6E+00	4.6E-04	2.2E+01	2.2E-03	9.1E+00	9.1E-04	2.4E+00	2.4E-04
PCB-81	1.0E-04	1.1E-01	1.1E-05	2.2E-01	2.2E-05	2.1E-01	2.1E-05	9.5E-01	9.5E-05	3.8E-01	3.8E-05	1.1E-01	1.1E-05
PCB-105	1.0E-04	7.4E+00	7.4E-04	1.3E+01	1.3E-03	1.1E+01	1.1E-03	6.3E+01	6.3E-03	2.5E+01	2.5E-03	7.0E+00	7.0E-04
PCB-114	5.0E-04	5.3E-01	2.7E-04	8.9E-01	4.5E-04	8.6E-01	4.3E-04	3.7E+00	1.9E-03	1.8E+00	9.0E-04	4.4E-01	2.2E-04
PCB-118	1.0E-04	1.1E+01	1.1E-03	2.5E+01	2.5E-03	2.5E+01	2.5E-03	1.2E+02	1.2E-02	5.0E+01	5.0E-03	1.4E+01	1.4E-03
PCB-123	1.0E-04	2.9E-01	2.9E-05	7.7E-01	7.7E-05	4.9E-01	4.9E-05	3.0E+00	3.0E-04	1.2E+00	1.2E-04	3.0E-01	3.0E-05
PCB-126	1.0E-01	4.1E-02	4.1E-03	9.8E-02	9.8E-03	9.0E-02	9.0E-03	4.5E-01	4.5E-02	1.8E-01	1.8E-02	5.0E-02	5.0E-03
PCB-156	5.0E-04	7.3E-01	3.7E-04	1.9E+00	9.5E-04	1.1E+00	5.5E-04	8.2E+00	4.1E-03	2.70E+00	1.4E-03	9.0E-01	4.5E-04
PCB-167	1.0E-05	2.5E-01	2.5E-06	5.1E-01	5.1E-06	2.8E-01	2.8E-06	2.3E+00	2.3E-05	6.7E-01	6.7E-06	2.7E-01	2.7E-06
PCB-189	1.0E-04		1.0E-04	8.9E-02	8.9E-06	6.8E-02	6.8E-06	4.3E-01	4.3E-05	1.4E-01	1.4E-05	6.0E-02	6.0E-06

Note: Blank Cells = Not Detected

EXHIBIT 6 - Continued

SEDIMENT AND FLOODPLAIN SOIL DIOXIN-LIKE PCB CONCENTRATION AND TEQ

PCB Congener	TEF	SAMPLE CONCENTRATION (ppb)													
		S05		S06		S07		S09		S10		S11		S12	
		Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ
PCB-77	1.00E-04	1.0E+01	1.0E-03	2.7E+00	2.7E-04	2.4E+01	2.4E-03	1.7E+01	1.7E-03	6.0E+00	6.0E-04	4.1E+00	4.1E-04	4.7E+01	4.7E-03
PCB-81	1.00E-04	4.4E-01	4.4E-05	1.1E-01	1.1E-05	1.1E+00	1.1E-04	5.7E-01	5.7E-05	2.6E-01	2.6E-05	1.8E-01	1.8E-05	1.7E+00	1.7E-04
PCB-105	1.00E-04	2.8E+01	2.8E-03	7.1E+00	7.1E-04	6.8E+01	6.8E-03	3.5E+01	3.5E-03	1.6E+01	1.6E-03	1.2E+01	1.2E-03	1.1E+02	1.1E-02
PCB-114	5.00E-04	2.1E+00	1.1E-03	5.1E-01	2.6E-04	6.3E+00	3.2E-03	3.2E+00	1.6E-03	1.1E+00	5.5E-04	8.5E-01	4.3E-04	1.0E+01	5.0E-03
PCB-118	1.00E-04	5.4E+01	5.4E-03	1.6E+01	1.6E-03	1.8E+02	1.8E-02	9.0E+01	9.0E-03	3.3E+01	3.3E-03	2.0E+01	2.0E-03	2.5E+02	2.5E-02
PCB-123	1.00E-04	1.4E+00	1.4E-04	3.1E-01	3.1E-05	3.3E+00	3.3E-04	1.5E+00	1.5E-04	8.3E-01	8.3E-05	7.4E-01	7.4E-05	5.5E+00	5.5E-04
PCB-126	1.00E-01	2.2E-01	2.2E-02			5.8E-01	5.8E-02			1.4E-01	1.4E-02	1.0E-01	1.0E-02	9.8E-01	9.8E-02
PCB-156	5.00E-04	3.3E+00	1.7E-03	8.4E-01	4.2E-04	1.3E+01	6.5E-03	6.7E+00	3.4E-03	2.1E+00	1.1E-03	1.6E+00	8.0E-04	1.5E+01	7.5E-03
PCB-167	1.00E-05	8.5E-01	8.5E-06	1.9E-01	1.9E-06	3.8E+00	3.8E-05	1.7E+00	1.7E-05	5.5E-01	5.5E-06	4.4E-01	4.4E-06	4.3E+00	4.3E-05
PCB-189	1.00E-04	2.3E-01	2.3E-05	4.9E-02	4.9E-06	1.1E+00	1.1E-04	5.6E-01	5.6E-05	1.5E-01	1.5E-05	6.4E-02	6.4E-06	2.2E+00	2.2E-04

Note: Blank Cells = Not Detected

EXHIBIT 6 - Continued

SEDIMENT AND FLOODPLAIN SOIL DIOXIN-LIKE PCB CONCENTRATION AND TEQ

PCB Congener	TEF	SAMPLE CONCENTRATION (ppb)													
		S13		S14		S15		S16		S17		S18		S19	
		Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ
PCB-77	1.00E-04	5.5E+00	5.5E-04	4.2E+01	4.2 E-03	2.7 E-01	2.7 E-05	2.7 E-01	2.7 E-05	2.9 E-01	2.9 E-05	3.1 E-02	3.1 E-06	1.2 E-02	1.2 E-06
PCB-81	1.00E-04	2.6E-01	2.6E-05	2.5E+00	2.5 E-04	1.1 E-02	1.1 E-06	1.6 E-02	1.6 E-06	1.4 E-02	1.4 E-06				
PCB-105	1.00E-04	1.5E+01	1.5E-03	1.5E+02	1.5 E-02	4.4 E-01	4.4 E-05	5.9 E-01	5.9 E-05	6.1 E-01	6.1 E-05	7.8 E-02	7.8 E-06	4.4 E-02	4.4 E-06
PCB-114	5.00E-04	1.2E+00	6.0E-04	1.3E+01	6.5 E-03	2.6 E-02	1.3 E-05	3.7 E-02	1.9 E-05	3.8 E-02	1.9 E-05				
PCB-118	1.00E-04	3.0E+01	3.0E-03	2.6E+02	2.6 E-02	8.4 E-01	8.4 E-05	1.2 E+00	1.2 E-04	1.3 E+00	1.3 E-04	1.5 E-01	1.5 E-05	1.1 E-01	1.1 E-05
PCB-123	1.00E-04	7.4E-01	7.4E-05	7.8E+00	7.8 E-04	2.8 E-02	2.8 E-06	3.3E-02	3.3 E-06	2.8E-02	2.8 E-06				
PCB-126	1.00E-01	1.2E-01	1.2E-02	1.3E+00	1.3E-01			7.1 E-03	7.1 E-04	7.6 E-03	7.6 E-04				
PCB-156	5.00E-04	1.3E+00	6.5E-04	2.0E+01	1.0E-02	5.2 E-02	2.6 E-05	1.0E-01	5.0 E-05	1.1 E-01	5.5 E-05	1.7 E-02	8.5 E-06	1.6 E-02	8.0 E-06
PCB-167	1.00E-05	3.6E-01	3.6E-06	5.5E+00	5.5E-05	2.2 E-02	2.2 E-07	3.5 E-02	3.5 E-07	3.7 E-02	3.7 E-07				
PCB-189	1.00E-04	7.6E-02	7.6E-06	1.0E+00	1.0E-04			7.5 E-03	7.5 E-07	6.1 E-03	6.1 E-07				

Note: Blank Cells = Not Detected

EXHIBIT 6 - Continued

SEDIMENT AND FLOODPLAIN SOIL DIOXIN-LIKE PCB CONCENTRATION AND TEQ

PCB Congener	TEF	SAMPLE CONCENTRATION (ppb)													
		S20		S21		S22		S23		S24		S25		S27	
		Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ
PCB-77	1.0E-04	2.6E-02	2.6E-06	9.3E-03	9.3E-07	2.4E+00	2.4E-04	3.2E+02	3.2E-02	1.1E+01	1.1E-03	1.1E+01	1.1E-03	2.3E+01	2.3E-03
PCB-81	1.0E-04					1.1E-01	1.1E-05	1.5E+01	1.5E-03	3.4E-01	3.4E-05	4.0E-01	4.0E-05	9.8E-01	9.8E-05
PCB-105	1.0E-04	1.4E-01	1.4E-05	4.7E-02	4.7E-06	8.8E+00	8.8E-04	7.6E+02	7.6E-02	3.9E+01	3.9E-03	3.0E+01	3.0E-03	6.6E+01	6.6E-03
PCB-114	5.0E-04					6.7E-01	3.4E-04	5.6E+01	2.8E-02	2.3E+00	1.2E-03	1.8E+00	9.0E-04	3.4E+00	1.7E-03
PCB-118	1.0E-04	3.1E-01	3.1E-05	1.0E-01	1.0E-05	1.4E+01	1.4E-03	1.3E+03	1.3E-01	1.2E+02	1.2E-02	6.5E+01	6.5E-03	1.2E+02	1.2E-02
PCB-123	1.0E-04					4.3E-01	4.3E-05	3.5E+01	3.5E-03	1.7E+00	1.7E-04	1.6E+00	1.6E-04	3.7E+00	3.7E-04
PCB-126	1.0E-01							5.3E+00	5.3E-01	3.1E-01	3.1E-02	3.0E-01	3.0E-02	5.1E-01	5.1E-02
PCB-156	5.0E-04	5.0E-02	2.5E-05			9.7E-01	4.9E-04	5.3E+01	2.7E-02	5.7E+00	2.9E-03	3.3E+00	1.7E-03	9.5E+00	4.8E-03
PCB-167	1.0E-05	1.6E-02	1.6E-07			2.8E-01	2.8E-06	1.4E+01	1.4E-04	1.5E+00	1.5E-05	8.9E-01	8.9E-06	2.5E+00	2.5E-05
PCB-189	1.0E-04					4.8E-02	4.8E-06	2.7E+00	2.7E-04	4.3E-01	4.3E-05	2.1E-01	2.1E-05	5.2E-01	5.2E-05

Note: Blank Cells = Not Detected

EXHIBIT 6 - Continued

SEDIMENT AND FLOODPLAIN SOIL DIOXIN-LIKE PCB CONCENTRATION AND TEQ

PCB Congener	TEF	SAMPLE CONCENTRATION (ppb)									
		S28		S29		S30		S31		S43	
		Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ
PCB-77	1.0E-04	3.1E+01	3.1E-03	1.4E+01	1.4E-03	7.5E-01	7.5E-05	8.6E+00	8.6E-04	2.2E+02	2.2E-02
PCB-81	1.0E-04	1.2E+00	1.2E-04	7.4E-01	7.4E-05	2.8E-02	2.8E-06	3.7E-01	3.7E-05	9.1E+00	9.1E-04
PCB-105	1.0E-04	8.3E+01	8.3E-03	3.7E+01	3.7E-03	1.6E+01	1.6E-03	2.1E+01	2.1E-03	4.4E+02	4.4E-02
PCB-114	5.0E-04	7.3E+00	3.7E-03	2.6E+00	1.3E-03	9.1E-01	4.6E-04	1.5E+00	7.5E-04	3.9E+01	2.0E-02
PCB-118	1.0E-04	2.0E+02	2.0E-02	6.4E+01	6.4E-03	4.1E+01	4.1E-03	4.9E+01	4.9E-03	9.8E+02	9.8E-02
PCB-123	1.0E-04	4.2E+00	4.2E-04	2.2E+00	2.2E-04	7.2E-01	7.2E-05	1.1E+00	1.1E-04	2.5E+01	2.5E-03
PCB-126	1.0E-01	7.6E-01	7.6E-02	2.6E-01	2.6E-02	4.2E-02	4.2E-03	1.8E-01	1.8E-02	3.4E+00	3.4E-01
PCB-156	5.0E-04	1.5E+01	7.5E-03	3.2E+00	1.6E-03	6.3E+00	3.2E-03	2.9E+00	1.5E-03	3.9E+01	2.0E-02
PCB-167	1.0E-05	3.9E+00	3.9E-05	8.8E-01	8.8E-06	1.9E+00	1.9E-05	7.7E-01	7.7E-06	1.0E+01	1.0E-04
PCB-189	1.0E-04	1.3E+00	1.3E-04	2.3E-01	2.3E-05	1.8E-01	1.8E-05	2.0E-01	2.0E-05	2.3E+00	2.3E-04

Note: Blank Cells: Not Detected

EXHIBIT 7

SEDIMENT AND FLOODPLAIN SOIL DIOXIN AND FURAN CONCENTRATION AND TEQ

DIOXIN/FURAN CONGENER	TEF	SAMPLE CONCENTRATION (ppt)											
		D32		D33		D42		S01		S03		S04	
		Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ
2,3,7,8-TCDF	1.0E-01	2.2E+00	2.2E-01	3.0E+00	3.0E-01	2.5E+00	2.5E-01	1.2E+01	1.2E+00	2.4E+00	2.4E-01	1.5E+00	1.5E-01
1,2,3,7,8-PeCDF	5.0E-02							1.2E+00	6.0E-02			3.3E-01	1.7E-02
2,3,4,7,8-PeCDF	5.0E-01			9.5E-01	4.8E-01	1.2E+00	6.0E-01	3.7E+00	1.9E+00	7.7E-01	3.9E-01	6.0E-01	3.0E-01
1,2,3,4,7,8-HxCDF	1.0E-01	6.5E-01	6.5E-02	1.1E+00	1.1E-01	1.2E+00	1.2E-01	2.9E+00	2.9E-01	6.9E-01	6.9E-02	6.9E-01	6.9E-02
2,3,4,6,7,8-HxCDF	1.0E-01					4.2E-01	4.2E-02	1.1E+00	1.1E-01			2.1E-01	2.1E-02
1,2,3,7,8,9-HxCDF	1.0E-01												
1,2,3,4,6,7,8-HpCDF	1.0E-02	2.3E+00	2.3E-02	2.9E+00	2.9E-02	4.9E+00	4.9E-02	8.5E+00	8.5E-02	4.0E+00	4.0E-02	2.5E+00	2.5E-02
OCDF	1.0E-04	4.4E+00	4.4E-04	4.5E+00	4.5E-04	1.1E+01	1.1E-03	1.8E+01	1.8E-03	7.9E+00	7.9E-04	4.2E+00	4.2E-04
2,3,7,8-TCDD	1.0E+00					9.3E-01	9.3E-01	8.0E-01	8.0E-01			6.0E-01	6.0E-01
1,2,3,7,8-PeCDD	1.0E+00	7.5E-01	7.5E-01			1.3E+00	1.3E+00	1.9E+00	1.9E+00	3.8E-01	3.8E-01	8.1E-01	8.1E-01
1,2,3,7,8,9-HxCDD	1.0E-01	1.4E+00	1.4E-01	5.8E-01	5.8E-02	2.5E+00	2.5E-01	4.1E+00	4.1E-01	1.1E+00	1.1E-01	1.7E+00	1.7E-01
1,2,3,4,6,7,8-HpCDD	1.0E-02	2.3E+01	2.3E-01	7.4E+00	7.4E-02	4.7E+01	4.7E-01	6.6E+01	6.6E-01	2.2E+01	2.2E-01	2.3E+01	2.3E-01
OCDD	1.0E-04	2.9E+02	2.9E-02	6.1E+01	6.1E-03	5.3E+02	5.3E-02	8.2E+02	8.2E-02	1.7E+02	1.7E-02	2.6E+02	2.6E-02
1,2,3,6,7,8-HxCDF	1.0E-01	6.4E-01	6.4E-02	6.5E-01	6.5E-02	1.5E+00	1.5E-01	2.6E+00	2.6E-01	5.6E-01	5.6E-02	7.3E-01	7.3E-02
1,2,3,4,7,8,9-HpCDF	1.0E-02							1.2E+00	1.2E-02				
1,2,3,4,7,8-HxCDD	1.0E-01					5.4E-01	5.4E-02	1.2E+00	1.2E-01	3.3E-01	3.3E-02	2.9E-01	2.9E-02
1,2,3,6,7,8-HxCDD	1.0E-01	1.6E+00	1.6E-01			2.5E+00	2.5E-01	3.6E+00	3.6E-01	1.4E+00	1.4E-01	1.2E+00	1.2E-01

Note: Blank Cells = Not Detected

EXHIBIT 7 - Continued

SEDIMENT AND FLOODPLAIN SOIL DIOXIN AND FURAN CONCENTRATION AND TEQ

DIOXIN /FURAN CONGENER	TEF	SAMPLE CONCENTRATION (ppt)													
		S05		S06		S07		S09		S10		S11		S12	
		Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ
2,3,7,8-TCDF	1.0E-01	4.1E+00	4.1E-01	5.0E+00	5.0E-01	3.9E+00	3.9E-01	1.2E+01	1.2E+00	3.9E+00	3.9E-01	7.4E-01	7.4E-02	3.3E+01	3.3E+00
1,2,3,7,8-PeCDF	5.0E-02	3.3E-01	1.7E-02	5.7E-01	2.9E-02	4.8E-01	2.4E-02	1.2E+00	6.0E-02	4.8E-01	2.4E-02			5.6E+00	2.8E-01
2,3,4,7,8-PeCDF	5.0E-01	1.3E+00	6.5E-01	3.3E+00	1.7E+00	1.5E+00	7.5E-01	5.1E+00	2.6E+00	1.3E+00	6.5E-01	2.9E-01	1.5E-01	2.0E+01	1.0E+01
1,2,3,4,7,8-HxCDF	1.0E-01	1.0E+00	1.0E-01	2.1E+00	2.1E-01	1.7E+00	1.7E-01	6.8E+00	6.8E-01	1.7E+00	1.7E-01			2.5E+01	2.5E+00
2,3,4,6,7,8-HxCDF	1.0E-01	2.8E-01	2.8E-02	5.0E-01	5.0E-02	2.8E-01	2.8E-02	1.1E+00	1.1E-01	4.0E-01	4.0E-02			3.6E+00	3.6E-01
1,2,3,7,8,9-HxCDF	1.0E-01							1.3E-01	1.3E-02						
1,2,3,4,6,7,8-HpCDF	1.0E-02	3.2E+00	3.2E-02	3.6E+00	3.6E-02	2.5E+00	2.5E-02	5.7E+00	5.7E-02	4.3E+00	4.3E-02	5.4E-01	5.4E-03	1.6E+01	1.6E-01
OCDF	1.0E-04	5.8E+00	5.8E-04	6.8E+00	6.8E-04	4.9E+00	4.9E-04	1.3E+01	1.3E-03	1.1E+01	1.1E-03	1.0E+00	1.0E-04	4.8E+01	4.8E-03
2,3,7,8-TCDD	1.0E+00	7.0E-01	7.0E-01	6.1E-01	6.1E-01			7.3E-01	7.3E-01	7.0E-01	7.0E-01			1.7E+00	1.7E+00
1,2,3,7,8-PeCDD	1.0E+00	1.1E+00	1.1E+00	6.0E-01	6.0E-01	7.4E-01	7.4E-01	1.1E+00	1.1E+00	1.1E+00	1.1E+00			2.0E+00	2.0E+00
1,2,3,7,8,9-HxCDD	1.0E-01	2.1E+00	2.1E-01	1.6E+00	1.6E-01	9.8E-01	9.8E-02	2.1E+00	2.1E-01	2.7E+00	2.7E-01			3.6E+00	3.6E-01
1,2,3,4,6,7,8-HpCDD	1.0E-02	3.0E+01	3.0E-01	2.2E+01	2.2E-01	1.5E+01	1.5E-01	4.1E+01	4.1E-01	5.0E+01	5.0E-01	1.5E+00	1.5E-02	5.7E+01	5.7E-01
OCDD	1.0E-04	2.8E+02	2.8E-02	1.8E+02	1.8E-02	1.5E+02	1.5E-02	3.9E+02	3.9E-02	5.3E+02	5.3E-02	1.3E+01	1.3E-03	5.6E+02	5.6E-02
1,2,3,6,7,8-HxCDF	1.0E-01	8.7E-01	8.7E-02	8.7E-01	8.7E-02	6.5E-01	6.5E-02	2.5E+00	2.5E-01	1.2E+00	1.2E-01			5.1E+00	5.1E-01
1,2,3,4,7,8,9-HpCDF	1.0E-02	3.8E-01	3.8E-03	6.7E-01	6.7E-03	4.4E-01	4.4E-03	2.1E+00	2.1E-02	6.0E-01	6.0E-03			5.1E+00	5.1E-02
1,2,3,4,7,8-HxCDD	1.0E-01	5.0E-01	5.0E-02	2.6E-01	2.6E-02			4.9E-01	4.9E-02	7.6E-01	7.6E-02			9.0E-01	9.0E-02
1,2,3,6,7,8-HxCDD	1.0E-01	2.0E+00	2.0E-01	1.3E+00	1.3E-01	8.0E-01	8.0E-02	2.1E+00	2.1E-01	2.7E+00	2.7E-01			4.5E+00	4.5E-01

Note: Blank Cells = Not Detected

EXHIBIT 7 - Continued

SEDIMENT AND FLOODPLAIN SOIL DIOXIN AND FURAN CONCENTRATION AND TEQ

DIOXIN /FURAN CONGENER	TEF	SAMPLE CONCENTRATION (ppt)													
		S13		S14		S15		S16		S17		S18		S19	
		Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ
2,3,7,8-TCDF	1.0E-01	2.7E+00	2.7E-01	2.4E+01	2.4E+00	1.1E+00	1.1E-01	1.7E+00	1.7E-01	1.9E+00	1.9E-01				
1,2,3,7,8-PeCDF	5.0E-02	4.8E-01	2.4E-02	3.4E+00	1.7E-01			3.6E-01	1.8E-02	4.9E-01	2.5E-02				
2,3,4,7,8-PeCDF	5.0E-01	1.1E+00	5.5E-01	8.8E+00	4.4E+00			5.2E-01	2.6E-01	6.6E-01	3.3E-01				
1,2,3,4,7,8-HxCDF	1.0E-01	1.3E+00	1.3E-01	9.5E+00	9.5E-01	5.2E-01	5.2E-02	9.0E-01	9.0E-02	1.0E+00	1.0E-01				
2,3,4,6,7,8-HxCDF	1.0E-01	4.0E-01	4.0E-02	2.7E+00	2.7E-01	2.5E-01	2.5E-02	3.0E-01	3.0E-02	4.6E-01	4.6E-02				
1,2,3,7,8,9-HxCDF	1.0E-01			3.0E-01	3.0E-02										
1,2,3,4,6,7,8-HpCDF	1.0E-02	6.2E+00	6.2E-02	2.2E+01	2.2E-01	3.1E+00	3.1E-02	6.8E+00	6.8E-02	5.5E+00	5.5E-02	1.0E+00	1.0E-02	1.4E+00	1.4E-02
OCDF	1.0E-04	2.8E+01	2.8E-03	3.9E+01	3.9E-03	1.0E+01	1.0E-03	3.1E+01	3.1E-03	1.6E+01	1.6E-03	2.8E+00	2.8E-04	4.9E+00	4.9E-04
2,3,7,8-TCDD	1.0E+00	7.6E-01	7.6E-01	1.0E+00	1.0E+00	6.8E-01	6.8E-01	1.3E+00	1.3E+00	6.3E-01	6.3E-01				
1,2,3,7,8-PeCDD	1.0E+00	1.4E+00	1.4E+00	2.5E+00	2.5E+00	1.4E+00	1.4E+00	1.7E+00	1.7E+00	9.5E-01	9.5E-01				
1,2,3,7,8,9-HxCDD	1.0E-01	2.4E+00	2.4E-01	7.0E+00	7.0E-01	1.9E+00	1.9E-01	3.5E+00	3.5E-01	2.2E+00	2.2E-01				
1,2,3,4,6,7,8-HpCDD	1.0E-02	4.9E+01	4.9E-01	1.6E+02	1.6E+00	3.4E+01	3.4E-01	6.1E+01	6.1E-01	4.3E+01	4.3E-01	4.4E+00	4.4E-02	4.3E+00	4.3E-02
OCDD	1.0E-04	4.7E+02	4.7E-02	1.1E+03	1.1E-01	2.9E+02	2.9E-02	5.5E+02	5.5E-02	4.2E+02	4.2E-02	3.8E+01	3.8E-03	4.0E+01	4.0E-03
1,2,3,6,7,8-HxCDF	1.0E-01	1.1E+00	1.1E-01	3.7E+00	3.7E-01	7.5E-01	7.5E-02	1.3E+00	1.3E-01	1.1E+00	1.1E-01	2.3E-01	2.3E-02	3.3E-01	3.3E-02
1,2,3,4,7,8,9-HpCDF	1.0E-02	6.6E-01	6.6E-03	2.5E+00	2.5E-02	3.4E-01	3.4E-03	5.6E-01	5.6E-03	5.1E-01	5.1E-03				
1,2,3,4,7,8-HxCDD	1.0E-01	6.2E-01	6.2E-02	2.5E+00	2.5E-01	4.3E-01	4.3E-02	8.3E-01	8.3E-02	6.1E-01	6.1E-02				
1,2,3,6,7,8-HxCDD	1.0E-01	2.4E+00	2.4E-01	9.4E+00	9.4E-01	2.0E+00	2.0E-01	3.3E+00	3.3E-01	2.3E+00	2.3E-01			2.7E-01	2.7E-02

Note: Blank Cells = Not Detected

EXHIBIT 7 - Continued

SEDIMENT AND FLOODPLAIN SOIL DIOXIN AND FURAN CONCENTRATION AND TEQ

DIOXIN /FURAN CONGENER	TEF	SAMPLE CONCENTRATION (ppt)													
		S20		S21		S22		S23		S24		S25		S27	
		Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ
2,3,7,8-TCDF	1.0E-01							4.9E+01	4.9E+00	3.5E+00	3.5E-01	6.1E+00	6.1E-01	1.1E+01	1.1E+00
1,2,3,7,8-PeCDF	5.0E-02							4.1E+00	2.1E-01	8.4E-01	4.2E-02	1.0E+00	5.0E-02	1.5E+00	7.5E-02
2,3,4,7,8-PeCDF	5.0E-01							2.2E+01	1.1E+01	2.3E+00	1.2E+00	2.6E+00	1.3E+00	4.0E+00	2.0E+00
1,2,3,4,7,8-HxCDF	1.0E-01	4.0E-01	4.0E-02	2.0E-01	2.0E-02			1.2E+01	1.2E+00	2.4E+00	2.4E-01	2.8E+00	2.8E-01	3.7E+00	3.7E-01
2,3,4,6,7,8-HxCDF	1.0E-01	3.1E-01	3.1E-02					1.9E+00	1.9E-01	7.8E-01	7.8E-02	9.7E-01	9.7E-02	1.1E+00	1.1E-01
1,2,3,7,8,9-HxCDF	1.0E-01													2.9E-01	2.9E-02
1,2,3,4,6,7,8-HpCDF	1.0E-02	3.6E+00	3.6E-02	3.5E+00	3.5E-02			8.9E+00	8.9E-02	1.4E+01	1.4E-01	2.1E+01	2.1E-01	8.0E+00	8.0E-02
OCDF	1.0E-04	1.1E+01	1.1E-03	8.9E+00	8.9E-04			2.1E+01	2.1E-03	2.9E+01	2.9E-03	4.9E+01	4.9E-03	2.2E+01	2.2E-03
2,3,7,8-TCDD	1.0E+00	1.3E+00	1.3E+00					1.3E+00	1.3E+00	1.5E+00	1.5E+00	1.6E+00	1.6E+00	2.0E+00	2.0E+00
1,2,3,7,8-PeCDD	1.0E+00	1.6E+00	1.6E+00					2.4E+00	2.4E+00	2.2E+00	2.2E+00	1.6E+00	1.6E+00	3.1E+00	3.1E+00
1,2,3,7,8,9-HxCDD	1.0E-01	3.7E+00	3.7E-01	8.5E-01	8.5E-02			5.2E+00	5.2E-01	4.5E+00	4.5E-01	3.8E+00	3.8E-01	5.5E+00	5.5E-01
1,2,3,4,6,7,8-HpCDD	1.0E-02	6.1E+01	6.1E-01	1.1E+01	1.1E-01	4.1E+00	4.1E-02	9.7E+01	9.7E-01	9.2E+01	9.2E-01	9.2E+01	9.2E-01	1.1E+02	1.1E+00
OCDD	1.0E-04	6.9E+02	6.9E-02	8.0E+01	8.0E-03	4.3E+01	4.3E-03	1.0E+03	1.0E-01	9.5E+02	9.5E-02	9.4E+02	9.4E-02	1.0E+03	1.0E-01
1,2,3,6,7,8-HxCDF	1.0E-01	9.8E-01	9.8E-02	5.8E-01	5.8E-02			4.7E+00	4.7E-01	2.7E+00	2.7E-01	3.8E+00	3.8E-01	2.4E+00	2.4E-01
1,2,3,4,7,8,9-HpCDF	1.0E-02							2.5E+00	2.5E-02	1.3E+00	1.3E-02	1.7E+00	1.7E-02	1.4E+00	1.4E-02
1,2,3,4,7,8-HxCDD	1.0E-01	7.1E-01	7.1E-02					1.0E+00	1.0E-01	1.1E+00	1.1E-01	9.7E-01	9.7E-02	1.3E+00	1.3E-01
1,2,3,6,7,8-HxCDD	1.0E-01	3.3E+00	3.3E-01					5.5E+00	5.5E-01	4.8E+00	4.8E-01	4.1E+00	4.1E-01	5.9E+00	5.9E-01

Note: Blank Cells = Not Detected

EXHIBIT 7 - Continued

SEDIMENT AND FLOODPLAIN SOIL DIOXIN AND FURAN CONCENTRATION AND TEQ

DIOXIN /FURAN CONGENER	TEF	SAMPLE CONCENTRATION (ppt)									
		S28		S29		S30		S31		S43	
		Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ
2,3,7,8-TCDF	1.0E-01	1.8E+01	1.8E+00	7.6E+00	7.6E-01	7.4E+00	7.4E-01	3.9E+00	3.9E-01	5.4E+01	5.4E+00
1,2,3,7,8-PeCDF	5.0E-02	2.1E+00	1.1E-01	1.3E+00	6.5E-02	1.2E+00	6.0E-02	6.8E-01	3.4E-02	4.2E+00	2.1E-01
2,3,4,7,8-PeCDF	5.0E-01	8.2E+00	4.1E+00	2.8E+00	1.4E+00	1.7E+00	8.5E-01	1.4E+00	7.0E-01	2.3E+01	1.2E+01
1,2,3,4,7,8-HxCDF	1.0E-01	8.9E+00	8.9E-01	2.4E+00	2.4E-01	2.5E+00	2.5E-01	1.6E+00	1.6E-01	1.8E+01	1.8E+00
2,3,4,6,7,8-HxCDF	1.0E-01	1.2E+00	1.2E-01	1.2E+00	1.2E-01	1.9E+00	1.9E-01	5.0E-01	5.0E-02	2.5E+00	2.5E-01
1,2,3,7,8,9-HxCDF	1.0E-01	2.7E-01	2.7E-02	2.1E-01	2.1E-02	2.2E-01	2.2E-02			3.0E-01	3.0E-02
1,2,3,4,6,7,8-HpCDF	1.0E-02	9.8E+00	9.8E-02	1.4E+01	1.4E-01	3.3E+01	3.3E-01	5.6E+00	5.6E-02	2.0E+01	2.0E-01
OCDF	1.0E-04	2.4E+01	2.4E-03	3.0E+01	3.0E-03	5.9E+01	5.9E-03	1.3E+01	1.3E-03	1.0E+02	1.0E-02
2,3,7,8-TCDD	1.0E+00	8.8E-01	8.8E-01	2.5E+00	2.5E+00	3.9E+00	3.9E+00	8.5E-01	8.5E-01	6.2E-01	6.2E-01
1,2,3,7,8-PeCDD	1.0E+00	1.7E+00	1.7E+00	5.2E+00	5.2E+00	2.6E+00	2.6E+00	1.1E+00	1.1E+00	1.3E+00	1.3E+00
1,2,3,7,8,9-HxCDD	1.0E-01	4.1E+00	4.1E-01	1.2E+01	1.2E+00	1.1E+01	1.1E+00	2.1E+00	2.1E-01	3.0E+00	3.0E-01
1,2,3,4,6,7,8-HpCDD	1.0E-02	8.8E+01	8.8E-01	2.2E+02	2.2E+00	2.6E+02	2.6E+00	4.2E+01	4.2E-01	1.4E+02	1.4E+00
OCDD	1.0E-04	1.0E+03	1.0E-01	2.3E+03	2.3E-01	2.0E+03	2.0E-01	3.6E+02	3.6E-02	2.0E+03	2.0E-01
1,2,3,6,7,8-HxCDF	1.0E-01	2.2E+00	2.2E-01	1.3E+00	1.3E-01	2.2E+00	2.2E-01	1.4E+00	1.4E-01	4.3E+00	4.3E-01
1,2,3,4,7,8,9-HpCDF	1.0E-02	2.4E+00	2.4E-02	1.9E+00	1.9E-02	3.0E+00	3.0E-02	5.9E-01	5.9E-03	4.5E+00	4.5E-02
1,2,3,4,7,8-HxCDD	1.0E-01	9.4E-01	9.4E-02	2.3E+00	2.3E-01	3.6E+00	3.6E-01	5.0E-01	5.0E-02	1.3E+00	1.3E-01
1,2,3,6,7,8-HxCDD	1.0E-01	4.3E+00	4.3E-01	1.1E+01	1.1E+00	1.4E+01	1.4E+00	2.2E+00	2.2E-01	7.5E+00	7.5E-01

Note: Blank Cells = Not Detected

Exhibit 8 presents a summary of the total PCB concentration for each sample based on PCB congener and Aroclor analysis to determine if Aroclor analysis is flawed. Additionally, the total dioxin-like PCB, dioxin, and furan concentrations in each sample are presented. The percentage of dioxin-like PCB congeners detected in each sample is also presented.

EXHIBIT 8
SUMMARY SEDIMENT AND FLOODPLAIN SOIL TOTAL CONCENTRATIONS

SAMPLE NUMBER	DIOXIN-LIKE PCB CONGENERS (ppm)	DIOXIN & FURAN CONGENERS (ppm)	TOTAL PCB-BASED ON TYPE OF AROCLOR (ppm)	TOTAL PCB-BASED ON PCB CONGENERS (ppm)	PERCENTAGE DIOXIN-LIKE CONGENERS IN TOTAL PCBs
AK STEEL AOC SAMPLES					
D32	2.2E-02	3.3E-04	2.00E-01 (A1248)	1.70E-01	13.0
D33	4.7E-02	8.2E-05	9.00E-01 (A1248)	9.90E-01	4.7
D42	4.4E-02	6.1E-04	1.10E+00 (A1248)	2.30E+00	1.9
S01	2.2E-01	9.5E-04	3.20E+00 (A1248)	4.90E+00	4.5
S03	9.1E-02	2.1E-04	2.10E+00 (A1248)	4.60E+00	2.0
S04	2.6E-02	3.0E-04	6.00E-01 (A1248)	1.20E+00	2.2
S05	1.0E-01	3.3E-04	3.30E+00 (A1248)	4.00E+00	2.5
S06	2.8E-02	2.3E-04	8.00E-01 (A1248)	2.00E+00	1.4
S07	3.0E-01	1.8E-04	2.00E+01 (A1242)	3.80E+01	0.8
S09	1.6E-01	4.9E-04	1.70E+01 (A1242)	2.40E+01	0.7
S10	6.0E-02	6.1E-04	1.40E+00 (A1248)	5.10E+00	1.2
S11	4.0E-02	1.7E-05	9.00E-01 (A1248)	9.00E-01	4.4
S12	4.5E-01	7.9E-04	1.50E+01 (A1242)	3.40E+01	1.3
S13	5.5E-02	5.7E-04	5.20E+00 (A1248)	2.50E+00	2.2
S14	5.0E-01	1.4E-03	3.90E+00 (A1248)	1.10E+01	4.5
S22	2.8E-02	4.7E-05	1.00E-01 (A1242)	2.00E-01	14.0
S23	2.6E+00	1.2E-03	3.90E+01 (A1248)	4.10E+01	6.3
S24	1.8E-01	1.1E-03	2.60E+00 (A1248)	5.50E+00	3.3
S25	1.1E-01	1.1E-03	2.60E+00 (A1248)	4.00E+00	2.8
S27	2.3E-01	1.2E-03	3.10E+00 (A1248)	3.70E+00	6.2
S28	3.5E-01	1.2E-03	1.80E+01 (A1248)	2.10E+01	1.7
S29	1.3E-01	2.6E-03	1.30E+00 (A1248)	1.70E+00	7.6

SAMPLE NUMBER	DIOXIN-LIKE PCB CONGENERS (ppm)	DIOXIN & FURAN CONGENERS (ppm)	TOTAL PCB-BASED ON TYPE OF AROCLOR (ppm)	TOTAL PCB-BASED ON PCB CONGENERS (ppm)	PERCENTAGE DIOXIN-LIKE CONGENERS IN TOTAL PCBs
S30	6.8E-02	2.4E-03	3.00E-01 (A1254)	6.00E-01	11.0
S31	8.6E-02	4.4E-04	2.20E+00 (A1248)	4.20E+00	2.0
S43	1.8E+00	2.4E-03	9.20E+01 (A1248)	8.80E+01	2.0
S15	1.7E-03	3.5E-04	ND	1.00E-01	NA
S16	2.3E-03	6.7E-04	ND	1.00E-01	NA
S17	2.4E-03	5.0E-04	ND	1.00E-01	NA
BACKGROUND AREA SAMPLES					
S18	2.8E-04	4.6E-05	ND	0	NA
S19	1.8E-04	5.1E-05	ND	0	NA
S20	5.4E-04	7.8E-04	ND	0	NA
S21	1.6E-04	1.1E-04	ND	0	NA

NA: Not applicable
ND: Non-detect

As previously described, samples were collected both upstream and downstream from sample location S17. Sediment and floodplain soils collected upstream from sample location S17 were evaluated as background samples. Samples collected downstream from sample location S17 were evaluated as representing uncontrolled releases from the AK Steel facility. The downstream and upstream samples were compared to determine if there was a significant statistical difference in mean concentrations from the upstream and downstream populations of PCB data sets. Exhibit 9 shows the comparative results of the statistical descriptors, which indicate the two populations are significantly different. A Wilcox-Rank Sum test showed the population medians were statistically different at a 95% confidence level. Further evidence of the difference between the two populations is presented graphically in bar charts and a box and whisker plot in Exhibits 10 and 11, respectively. The actual fingerprints of the two data sets are developed and compared in Appendix A.

EXHIBIT 9
COMPARING TOTAL PCB SEDIMENT AND FLOODPLAIN SOIL CONCENTRATIONS IN CONTAMINATED DOWNSTREAM AND BACKGROUND AREAS

STATISTIC	AK STEEL AOC TOTAL PCB CONGENERS	BACKGROUND TOTAL PCB CONGENERS
Number of Samples	26.0	4
Mean Concentration (ppm)	11.6	0.0052
Variance (ppm)	393	2.2E-6
Standard Deviation (ppm)	19.8	1.5E-3
Minimum Concentration (ppm)	0.1	3.5E-3
Maximum Concentration (ppm)	88	6.7E-3

EXHIBIT 10
HISTOGRAM COMPARISON BETWEEN CONTAMINATED AND BACKGROUND SEDIMENTS AND FLOODPLAIN SOILS

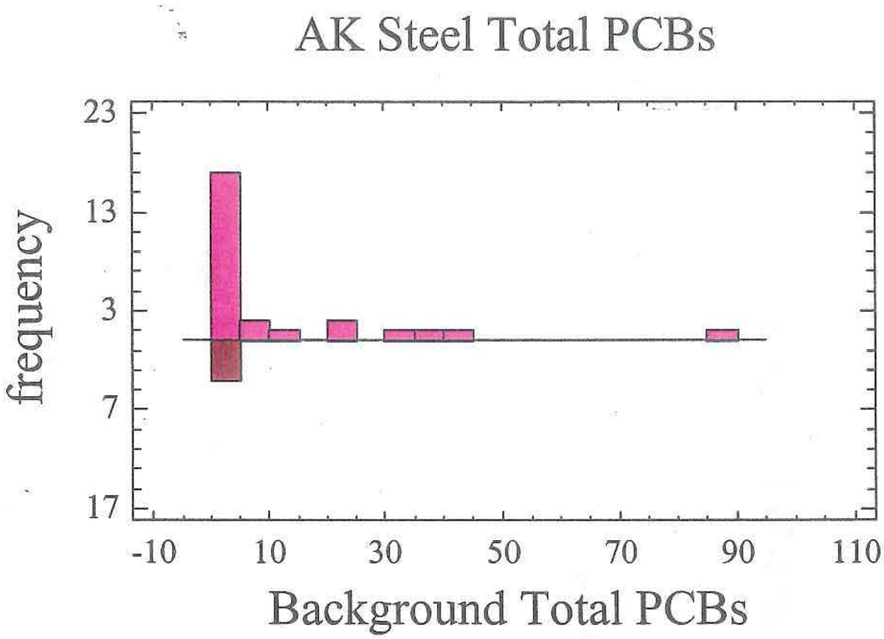
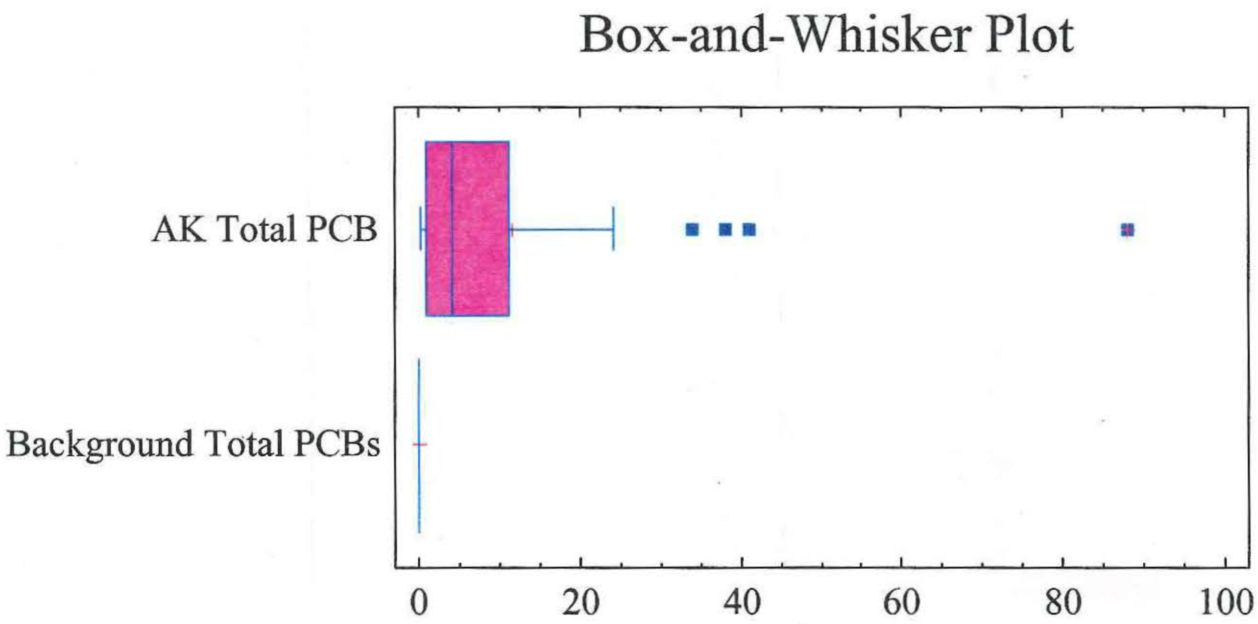


EXHIBIT 11
BOX AND WHISKER PLOT COMPARISON BETWEEN CONTAMINATED AND BACKGROUND SEDIMENTS AND FLOODPLAIN SOILS



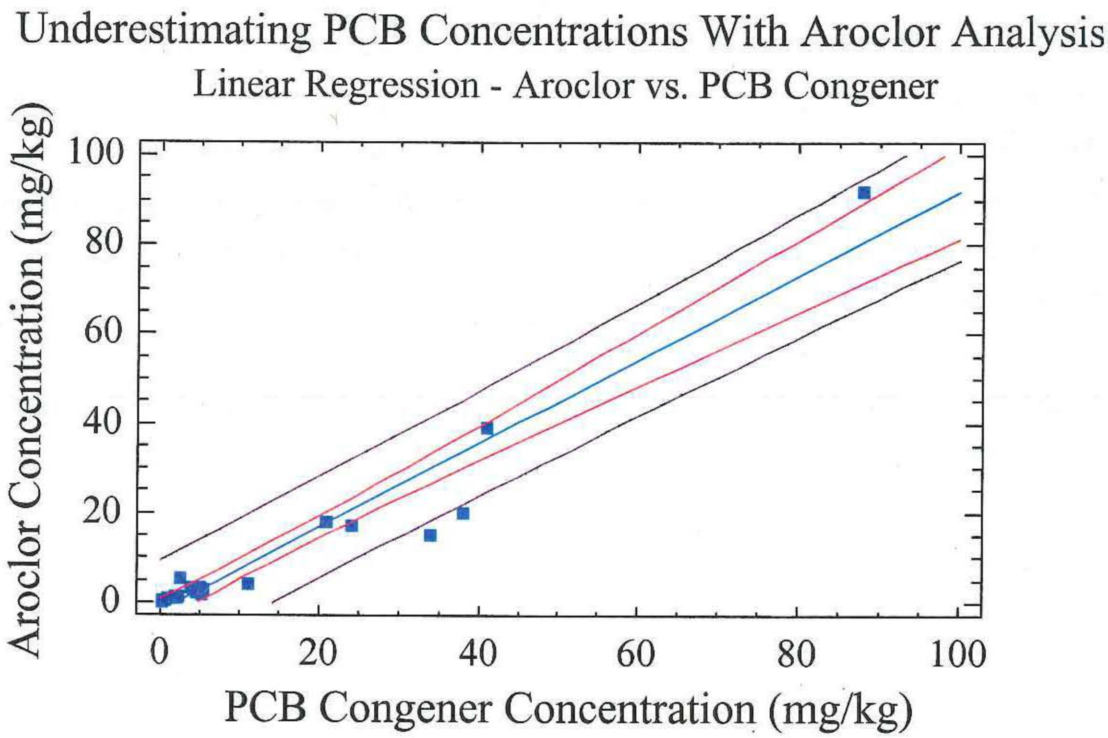
As previously discussed, each sediment and floodplain sample was analyzed for total PCB concentrations based on Aroclor, homolog, and PCB congener analysis to determine if Aroclor and homolog data truly represent contaminant conditions. It is clear from Exhibits 12 and 13 that both Aroclor and homolog data under-represent total PCB contaminant conditions based on linear regression analyses where total PCB concentrations based on Aroclor versus PCB congener and homolog versus PCB congener analyses are plotted.

As shown in Exhibit 12, the correlation coefficient of 0.92 reveals Aroclor and PCB congener data are highly correlated (with the association between Aroclor and PCB congeners, represented by R-squared, explaining 82% of the variability). The linear regression equation (which describes the mathematical relationship between Aroclor and PCB congener data) indicates Aroclor analysis significantly underestimates the total concentrations of PCB in sediments. If Aroclor and PCB congener analytical results were equivalent, the slope would be 1.0. However, the slope of the line of the equation is only 0.68 indicating that, on average, Aroclor data represent only 68% of the total PCB concentration present in the sample. In other words, Aroclor data under-report PCB contamination, and the corresponding human health risks for total PCBs, by 32% on average.

Exhibit 13 shows the same trend for homolog data, where the homolog data underestimate the total PCB contamination by 77%.

EXHIBIT 12
COMPARING TOTAL PCB CONCENTRATIONS IN SEDIMENTS AND FLOODPLAIN SOILS USING AROCLOR AND PCB CONGENER ANALYSIS

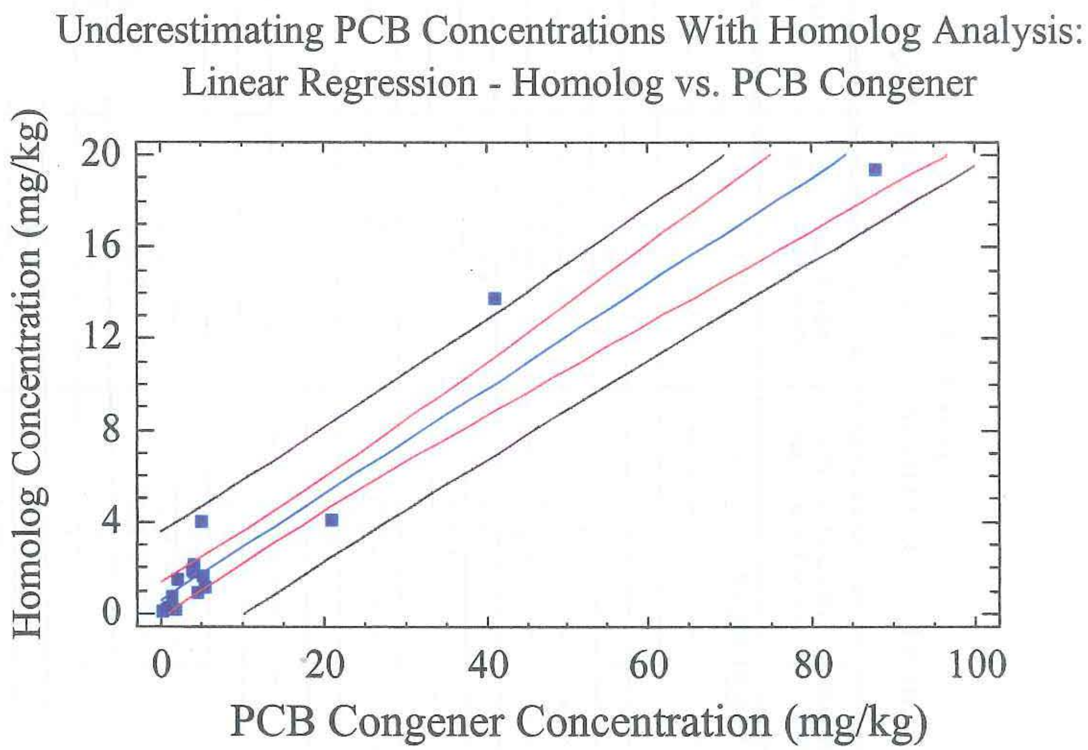
Linear Regression Equation:
Aroclor Concentration = -0.17 + 0.68* PCB Congener Concentration
Correlation Coefficient = 0.92
R-squared = 86%



Note: Each point represents the total PCB concentration in the sample that was analyzed for both Aroclor and PCB congeners. Center line represents the best-fit line. The hashed lines bounding the best-fit line represent the 95% confidence limits for the best-fit line. The outermost solid lines represent the 95% confident prediction intervals.

EXHIBIT 13
COMPARING TOTAL PCB CONCENTRATIONS IN SEDIMENTS AND FLOODPLAIN SOILS USING HOMOLOG AND PCB CONGENER ANALYSIS

Linear Regression Equation:
Homolog Concentration= 0.58+ 0.23*Congener Concentration
Correlation Coefficient = 0.97
R-squared = 94%



Note: Each point represents the total PCB concentration in the sample that was analyzed for both homologs and PCB congeners. Center line represents the best-fit line. The hashed lines bounding the best-fit line represent the 95% confidence limits for the best-fit line. The outermost solid lines represent the 95% confident prediction intervals.

Exhibit 14 presents the total dioxin TEQ concentrations for each sediment and floodplain sample for dioxin-like PCBs, and dioxins and furans, as well as the total TEQ for the sample.

EXHIBIT 14
SEDIMENT AND FLOODPLAIN SOIL TOTAL TEQ

SEDIMENT AND FLOODPLAIN SOIL SAMPLE NUMBER	DIOXIN-LIKE PCB CONGENERS (ppm)	DIOXIN & FURAN CONGENERS (ppm)	TOTAL TEQ (ppm)
CONTAMINATED DOWNSTREAM AREA			
D32	1.7E-05	1.7E-06	1.9E-05
D33	1.6E-05	1.1E-06	1.7E-05
D42	1.4E-05	4.5E-06	1.9E-05
S01	7.2E-05	8.2E-06	8.0E-05
S03	2.9E-05	1.7E-06	3.1E-05
S04	8.1E-06	2.6E-06	1.1E-05
S05	3.4E-05	3.9E-06	3.8E-05
S06	3.3E-06	4.3E-06	7.6E-06
S07	9.5E-05	2.5E-06	9.8E-05
S09	1.9E-05	7.7E-06	2.7E-05
S10	2.1E-05	4.4E-06	2.6E-05
S11	1.5E-05	2.4E-07	1.5E-05
S12	1.5E-04	2.2E-05	1.7E-04
S13	1.8E-05	4.4E-06	2.3E-05
S14	1.9E-04	1.6E-05	2.1E-04
S22	3.4E-06	4.5E-08	3.4E-06
S23	8.3E-04	2.4E-05	8.5E-04
S24	5.2E-05	8.0E-06	6.0E-05
S25	4.3E-05	8.0E-06	5.1E-05
S27	7.9E-05	1.2E-05	9.0E-05
S28	1.2E-04	1.2E-05	1.3E-04
S29	4.1E-05	1.6E-05	5.6E-05
S30	1.4E-05	1.5E-05	2.9E-05
S31	2.8E-05	4.4E-06	3.3E-05

SEDIMENT AND FLOODPLAIN SOIL SAMPLE NUMBER	DIOXIN-LIKE PCB CONGENERS (ppm)	DIOXIN & FURAN CONGENERS (ppm)	TOTAL TEQ (ppm)
S43	5.5E-04	2.5E-05	5.7E-04
S15	2.0E-07	3.2E-06	3.4E-06
S16	9.9E-07	5.2E-06	6.2E-06
S17	1.1E-06	3.4E-06	4.5E-06
BACKGROUND			
S18	3.4E-08	8.1E-08	1.2E-07
S19	2.5E-08	1.2E-07	1.5E-07
S20	7.3E-08	4.6E-06	4.6E-06
S21	1.60E-08	3.2E-07	3.2E-07

Fish Analytical Results

The analytical results for dioxin-like PCB congeners, and dioxins and furans in sediment and floodplain soils are presented in Exhibits 15 and 16.

EXHIBIT 15
FISH DIOXIN-LIKE PCB CONGENER CONCENTRATION AND TEQ

PCB Congener	TEF	SAMPLE CONCENTRATION (ppb)													
		258-2002/FT001		259-2002/FT002		260-2002/FT003		261-2002/FT004		262-2002/FT005		263-2002/FT006		264-2002/FT007	
		Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ
PCB-77	1.0E-04	1.3E+01	1.3E-03	6.3E+00	6.3E-04	9.2E-01	9.2E-05	1.5E+00	1.5E-04	9.0E-01	9.0E-05	4.0E+00	4.0E-04	6.5E+00	6.5E-04
PCB-81	1.0E-04	1.1E+00	1.1E-04	5.7E-01	5.7E-05	4.3E-01	4.3E-05	5.3E-01	5.3E-05	2.1E-01	2.1E-05	4.7E-01	4.7E-05	4.7E-01	4.7E-05
PCB-105	1.0E-04	1.4E+02	1.4E-02	6.8E+01	6.8E-03	4.5E+01	4.5E-03	3.1E+01	3.1E-03	1.7E+01	1.7E-03	1.4E+02	1.4E-02	4.7E+01	4.7E-03
PCB-114	5.0E-04	1.2E+01	6.0E-03	6.3E+00	3.2E-03	3.9E+00	2.0E-03	2.9E+00	1.5E-03	1.5E+00	7.5E-04	1.3E+01	6.5E-03	4.4E+00	2.2E-03
PCB-118	1.0E-04	3.4E+02	3.4E-02	1.6E+02	1.6E-02	1.1E+02	1.1E-02	7.4E+01	7.4E-03	4.3E+01	4.3E-03	3.8E+02	3.8E-02	1.1E+02	1.1E-02
PCB-123	1.0E-04	7.5E+00	7.5E-04	3.8E+00	3.8E-04	2.5E+00	2.5E-04	2.0E+00	2.0E-04	1.1E+00	1.1E-04	6.9E+00	6.9E-04	2.8E+00	2.8E-04
PCB-126	1.0E-01	7.4E-01	7.4E-02	3.5E-01	3.5E-02	2.6E-01	2.6E-02	2.0E-01	2.0E-02	9.7E-02	9.7E-03	7.2E-01	7.2E-02	1.9E-01	1.9E-02
PCB-156	5.0E-04	1.3E+01	6.5E-03	8.8E+00	4.4E-03	5.1E+00	2.6E-03	3.6E+00	1.8E-03	2.2E+00	1.1E-03	2.2E+01	1.1E-02	6.8E+00	3.4E-03
PCB-167	1.0E-05	4.1E+00	4.1E-05	2.8E+00	2.8E-05	1.8E+00	1.8E-05	1.3E+00	1.3E-05	8.5E-01	8.5E-06	7.4E+00	7.4E-05	2.3E+00	2.3E-05
PCB-169	1.0E-02			7.4E-02	7.4E-04	1.9E-02	1.9E-04					1.5E-01	1.5E-03	5.7E-02	5.7E-04
PCB-189	1.0E-04	8.0E-01	8.0E-05	6.4E-01	6.4E-05	3.2E-01	3.2E-05	2.5E-01	2.5E-05	1.3E-01	1.3E-05	1.5E+00	1.5E-04	5.1E-01	5.1E-05

Note: Blank Cells = Not Detected

EXHIBIT 15-CONTINUED
FISH DIOXIN-LIKE PCB CONGENER CONCENTRATION AND TEQ

PCB Congener	TEF	SAMPLE CONCENTRATION (ppb)					
		265-2002/FT008		266-2002/FT009		267-2002/FT010	
		Conc.	TEQ	Conc.	TEQ	Conc.	TEQ
PCB-77	1.0E-04	3.7E+00	3.7E-04			7.2E+00	7.2E-04
PCB-81	1.0E-04	1.7E+00	1.7E-04	1.0E+00	1.0E-04	7.7E-01	7.7E-05
PCB-105	1.0E-04	1.7E+02	1.7E-02	1.6E+02	1.6E-02	1.0E+02	1.0E-02
PCB-114	5.0E-04	1.5E+01	7.5E-03	1.4E+01	7.0E-03	8.6E+00	4.3E-03
PCB-118	1.0E-04	4.4E+02	4.4E-02	4.7E+02	4.7E-02	2.7E+02	2.7E-02
PCB-123	1.0E-04	1.1E+01	1.1E-03	9.3E+00	9.3E-04	6.3E+00	6.3E-04
PCB-126	1.0E-01	9.6E-01	9.6E-02	7.5E-01	7.5E-02	5.9E-01	5.9E-02
PCB-156	5.0E-04	3.4E+01	1.7E-02	2.1E+01	1.1E-02	1.3E+01	6.5E-03
PCB-167	1.0E-05	1.2E+01	1.2E-04	8.8E+00	8.8E-05	5.3E+00	5.3E-05
PCB-169	1.0E-02	3.0E-01	3.0E-03	2.1E-01	2.1E-03		
PCB-189	1.0E-04	1.7E+00	1.7E-04	1.1E+00	1.1E-04	1.2E+00	1.2E-04

Note: Blank Cells = Not Detected

EXHIBIT 16
FISH DIOXIN AND FURAN CONCENTRATION AND TEQ

DIOXIN /FURAN CONGENER	TEF	SAMPLE CONCENTRATION (ppt)													
		258-2002/FT001		259-2002/FT002		260-2002/FT003		261-2002/FT004		262-2002/FT005		263-2002/FT006		264-2002/FT007	
		Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ
2,3,7,8-TCDF	1.0E-01	8.3E-01	8.3E-02	8.4E-01	8.4E-02			3.9E-01	3.9E-02	4.4E-01	4.4E-02	4.1E-01	4.1E-02	1.7E+00	1.7E-01
1,2,3,7,8-PeCDF	5.0E-02														
2,3,4,7,8-PeCDF	5.0E-01	1.1E+00	1.1E-01	7.0E-01	7.0E-02	4.5E-01	4.5E-02	2.8E-01	2.8E-02	5.4E-01	5.4E-02	7.7E-01	7.7E-02	3.7E-01	3.7E-02
1,2,3,4,7,8-HxCDF	1.0E-01	2.8E-01	2.8E-02	2.9E-01	2.9E-02			6.3E-02	6.3E-03	1.5E-01	1.5E-02	2.4E-01	2.4E-02		0.0E+00
2,3,4,6,7,8-HxCDF	1.0E-01														
1,2,3,7,8,9-HxCDF	1.0E-01														
1,2,3,4,6,7,8-HpCDF	1.0E-02														
OCDF	1.0E-04														
2,3,7,8-TCDD	1.0E+00	5.9E-01	5.9E-02	6.4E-01	6.4E-02	2.9E-01	2.9E-02	3.2E-01	3.2E-02	5.0E-01	5.0E-02	5.9E-01	5.9E-02	4.0E-01	4.0E-02
1,2,3,7,8-PeCDD	1.0E+00	5.1E-01	5.1E-02	3.3E-01	3.3E-02	2.8E-01	2.8E-02	3.3E-01	3.3E-02	3.6E-01	3.6E-02	4.9E-01	4.9E-02	7.4E-01	7.4E-02
1,2,3,7,8,9-HxCDD	1.0E-01							2.1E-01	2.1E-02	1.5E-01	1.5E-02				
1,2,3,4,6,7,8-HpCDD	1.0E-02	1.3E+00	1.3E-01	6.3E-01	6.3E-02	2.9E-01	2.9E-02	8.5E-01	8.5E-02	4.6E-01	4.6E-02	9.5E-01	9.5E-02	7.9E-01	7.9E-02
OCDD	1.0E-04	3.6E+00	3.6E-01	1.9E+00	1.9E-01	1.8E+00	1.8E-01	3.9E+00	3.9E-01	1.1E+00	1.1E-01	3.3E+00	3.3E-01	4.2E+00	4.2E-01
1,2,3,6,7,8-HxCDF	1.0E-01	2.1E+00	2.1E-01	5.1E+00	5.1E-01	1.7E+00	1.7E-01	7.7E-01	7.7E-02	1.2E+00	1.2E-01	3.3E+00	3.3E-01	2.7E+00	2.7E-01
1,2,3,4,7,8,9-HpCDF	1.0E-02														
1,2,3,4,7,8-HxCDD	1.0E-01							9.6E-02	9.6E-03						
1,2,3,6,7,8-HxCDD	1.0E-01	4.5E-01	4.5E-02			1.2E-01	1.2E-02	3.4E-01	3.4E-02	3.6E-01	3.6E-02	3.4E-01	3.4E-02		

Note: Blank Cells = Not Detected

EXHIBIT 16-CONTINUED
FISH DIOXIN AND FURAN CONCENTRATION AND TEQ

DIOXIN /FURAN CONGENER	TEF	SAMPLE CONCENTRATION (ppt)					
		258-2002/FT008		259-2002/FT009		260-2002/FT010	
		Conc.	TEQ	Conc.	TEQ	Conc.	TEQ
2,3,7,8-TCDF	1.0E-01	1.1E+00	1.1E-01			8.5E-01	8.5E-02
1,2,3,7,8-PeCDF	5.0E-02						
2,3,4,7,8-PeCDF	5.0E-01	1.8E+00	1.8E-01	2.2E+00	2.2E-01	1.6E+00	1.6E-01
1,2,3,4,7,8-HxCDF	1.0E-01	4.9E-01	4.9E-02	3.1E-01	3.1E-02	2.5E-01	2.5E-02
2,3,4,6,7,8-HxCDF	1.0E-01					2.1E-01	2.1E-02
1,2,3,7,8,9-HxCDF	1.0E-01						
1,2,3,4,6,7,8-HpCDF	1.0E-02					5.9E-01	5.9E-02
OCDF	1.0E-04					4.4E-01	4.4E-02
2,3,7,8-TCDD	1.0E+00	1.5E+00	1.5E-01	1.3E+00	1.3E-01	7.9E-01	7.9E-02
1,2,3,7,8-PeCDD	1.0E+00	1.4E+00	1.4E-01	1.2E+00	1.2E-01	7.5E-01	7.5E-02
1,2,3,7,8,9-HxCDD	1.0E-01	5.3E-01	5.3E-02				
1,2,3,4,6,7,8-HpCDD	1.0E-02	3.0E+00	3.0E-01	1.1E+00	1.1E-01	1.9E+00	1.9E-01
OCDD	1.0E-04	3.1E+00	3.1E-01	1.6E+00	1.6E-01	4.3E+00	4.3E-01
1,2,3,6,7,8-HxCDF	1.0E-01	1.7E+01	1.7E+00	6.8E+00	6.8E-01	1.1E+01	1.1E+00
1,2,3,4,7,8,9-HpCDF	1.0E-02						
1,2,3,4,7,8-HxCDD	1.0E-01	2.8E-01	2.8E-02			3.6E-01	3.6E-02
1,2,3,6,7,8-HxCDD	1.0E-01	1.2E+00	1.2E-01	8.0E-01	8.0E-02	7.1E-01	7.1E-02

Note: Blank Cells = Not Detected

Exhibit 17 presents a summary of the total PCB concentration for each sample based on PCB congener and Aroclor analysis to determine if Aroclor analysis is flawed. Additionally, the total dioxin-like PCB, dioxin, and furan concentrations in each sample are presented. The percentage of dioxin-like PCB congeners detected in each sample is also presented.

EXHIBIT 17
FISH DIOXIN AND FURAN TOTAL CONCENTRATION

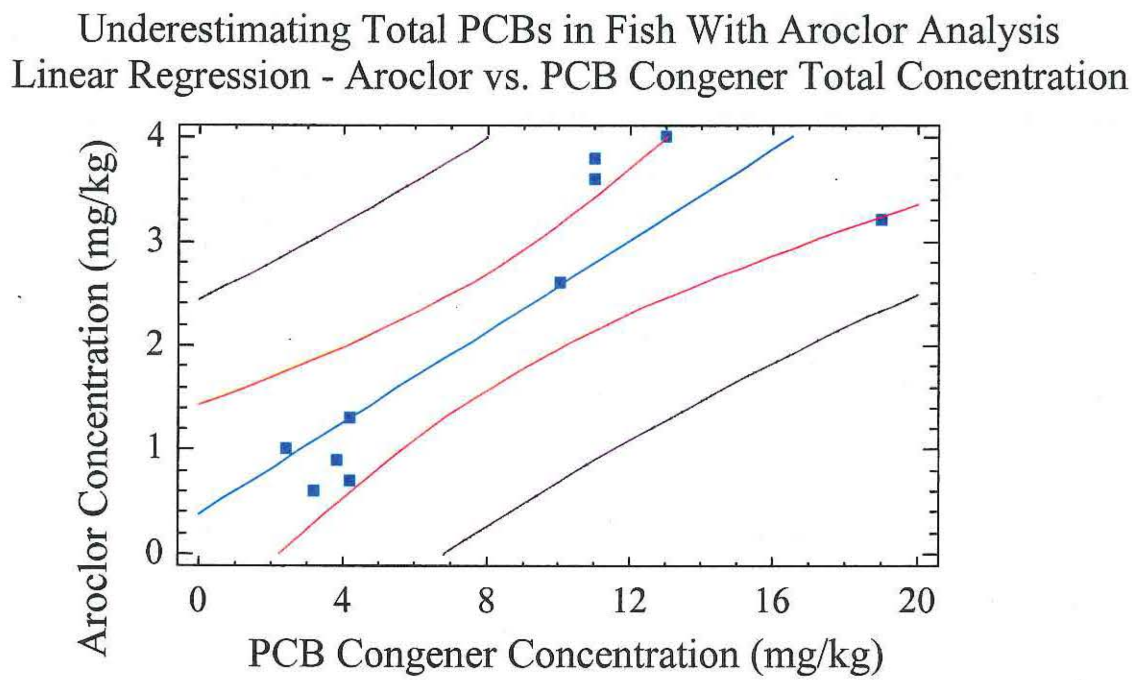
FISH SAMPLE NUMBER	PCB DIOXIN-LIKE CONGENERS (ppm)	DIOXIN & FURAN CONGENERS (ppm)	TOTAL PCB- BASED ON AROCLORS (ppm)	TOTAL PCB-BASED ON PCB CONGENERS (ppm)	PERCENTAGE OF DIOXIN-LIKE CONGENERS IN TOTAL PCBs
258-2002/FT001	5.3E-01	1.1E-05	3.2E+00	1.9E+01	2.8
259-2002/FT002	2.6E-01	1.0E-05	1.3E+00	4.2E+00	6.2
260-2002/FT003	1.7E-01	4.9E-06	6.0E-01	3.2E+00	5.3
261-2002/FT004	1.2E-01	7.5E-06	9.0E-01	3.8E+00	3.2
262-2002/FT005	6.7E-02	5.3E-06	1.0E+00	2.4E+00	2.8
263-2002/FT006	5.8E-01	1.0E-05	3.6E+00	1.1E+01	5.3
264-2002/FT007	1.8E-01	1.1E-05	7.0E-01	4.2E+00	4.3
265-2002/FT008	6.9E-01	3.1E-05	2.6E+00	1.0E+01	6.9
266-2002/FT009	6.9E-01	1.5E-05	3.8E+00	1.1E+01	6.3
267-2002/FT010	4.1E-01	2.4E-05	4.0E+00	1.3E+01	3.2

As previously discussed, each fish sample was analyzed for total PCB concentrations based on both Aroclor and PCB congener analysis to determine if Aroclor data truly represent contaminant conditions. As was true for sediments, it is clear from this study that Aroclors under-represent contaminant conditions. Exhibit 18 shows the results from a linear regression analysis where total PCB concentrations based on Aroclor and PCB congener analysis are plotted.

The correlation coefficient of 0.85 reveals Aroclor and PCB congener data are highly correlated (with the association between Aroclor and PCB congeners, represented by R-squared, explaining 73% of the variability). The linear regression equation (which describes the mathematical relationship between Aroclor and PCB congener data) indicates Aroclor analysis significantly underestimates the total concentrations of PCB in fish. If Aroclor and PCB congener analytical results were equivalent, the slope would be 1.0. However, the slope of the line of the equation is only 0.21, indicating that, on average, Aroclor data represent only 21% of the total PCB concentration present in the sample. In other words, Aroclor data under-report PCB contamination, and the corresponding human health risks for total PCBs, by 79% on average. This underestimation of fish contamination based on Aroclor data is even greater than was the case for sediments.

EXHIBIT 18
COMPARING TOTAL PCB CONCENTRATIONS IN FISH SAMPLES USING AROCLOR AND PCB CONGENER ANALYSIS

<u>Linear Regression Equation</u>
Aroclor Concentration = 0.37 + 0.21*PCB Congener Concentration
Correlation Coefficient = 0.85
R-squared = 73%



Note: Each point represents the total PCB concentration in the sample that was analyzed for both Aroclor and PCB congeners. Center line represents the best-fit line. The hashed lines bounding the best-fit line represents the95% confidence limits for the best-fit line. The outermost solid lines represent the 95% confident prediction intervals.

Exhibit 19 presents the total dioxin TEQ concentrations for each fish sample for dioxin-like PCBs, and dioxins and furans, as well as the total TEQ for the sample.

EXHIBIT 19
FISH TOTAL TEQ

FISH SAMPLE NUMBER	DIOXIN-LIKE PCB CONGENERS (ppm)	DIOXIN & FURAN CONGENERS (ppm)	TOTAL TEQ (ppm)
258-2002/FT001	1.4E-04	1.1E-06	1.4E-04
259-2002/FT002	6.7E-05	1.0E-06	6.8E-05
260-2002/FT003	4.7E-05	4.9E-07	4.7E-05
261-2002/FT004	3.4E-05	7.5E-07	3.5E-05
262-2002/FT005	1.8E-05	5.3E-07	1.9E-05
263-2002/FT006	1.4E-04	1.0E-06	1.4E-04
264-2002/FT007	4.2E-05	1.1E-06	4.3E-05
265-2002/FT008	1.9E-04	3.1E-06	1.9E-04
266-2002/FT009	1.6E-04	1.5E-06	1.6E-04
267-2002/FT010	1.1E-04	2.4E-06	1.1E-04

Exhibit 20 compares the maximum detected concentration in fish to the risk based screening level. Note that the fish concentrations far exceed the maximum fish levels.

EXHIBIT 20
COMPARING CONTAMINANT LEVELS IN DICK'S CREEK FISH TO *DE MINIMUS* RISK-BASED SCREENING LEVELS

SCREENING CONTAMINATED EXPOSURE MEDIA	MAXIMUM DETECTED CONCENTRATION (mg/kg)	RISK-BASED SCREENING CONCENTRATION
AOC-1 – RECREATIONAL FISH		
Dioxin-like PCB TEQ	1.9E-04	2.56E-8
Dioxin-furan TEQ	3.1E-06	2.56E-8
Total PCBs	6.9E-01	2E-03
AOC-1 – SUBSISTENCE FISH		
Dioxin-like PCB TEQ	1.9E-04	2.56E-9
Dioxin-furan TEQ	3.1E-06	2.56E-9
Total PCBs	6.9E-01	2.45E-4
AOC-2 -RECREATIONAL FISH		
Dioxin-like PCB TEQ	1.4E-04	2.56E-8
Dioxin-furan TEQ	1.1E-06	2.56E-8
Total PCBs	5.8E-01	2E-03
AOC-2 – SUBSISTENCE FISH		
Dioxin-like PCB TEQ	1.4E-04	2.56E-9
Dioxin-furan TEQ	3.1E-06	2.56E-9
Total PCBs	6.9E-01	2.45E-4

Note: Risk-Based Screening Levels Are *de minimus* (i.e., equal to 1E-6 cancer risk) modified from *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories Volume 1 Fish Sampling and Analysis, Third Edition* (EPA 823-B-00-007 2000)

2.4 EXPOSURE ASSESSMENT

The exposure assessment is an evaluation of exposure for potential human receptors that currently contact or are expected to come into contact with PCBs in Dick's Creek and its tributaries, as well as the possible routes, magnitudes, frequencies, and durations of exposure. The primary goal of an exposure assessment is to quantify the average daily dose of PCBs that receptors will receive while engaged in recreational activities in Dick's Creek and Monroe Ditch. The doses of total PCBs, dioxin-like PCBs, and dioxins and furans are estimated for current and potential future receptors. The exposure assessment is based on USEPA guidance (1989; 1996) and site-specific information based on a site visit to directly observe exposure conditions.

Steps taken in the exposure assessment to quantify dose are as follows:

- Characterize the exposure setting and identify potential current and potential future human receptors;
- Identify complete exposure pathways and routes of exposure for each potential receptor;
- Estimate EPCs based on using each sample location as an exposure point;
- Quantify chemical intake for individual exposure pathways for each potential receptor; and
- Combine chemical intakes across exposure pathways for each potential receptor.

This paradigm for evaluating exposure follows USEPA guidance. The following equation and generalized exposure parameters are used to estimate human exposure conditions at Dick's Creek:

$$\text{Intake} = C*CR*EF*ED*FI*(1/BW)*(1/AT)$$

I = Intake (milligram per kilogram body weight - day, [mg/kg-day])

C = Chemical concentration in contaminated medium (milligram per kilogram [mg/kg])

CR = Contact rate or ingestion rate (mg/day)

EF = Exposure frequency; how often exposure occurs (days/year)

ED = Exposure duration; how long exposure occurs (years)

BW = Body weight (kg)

AT = Averaging time; period over which exposure is averaged (days)

Although ingestion of surface water is also typically included at similar hazardous waste sites, it was not evaluated in this risk assessment. Water samples collected from Dick's Creek have consistently shown minimal contaminant concentrations. This is likely due to the relative insolubility of PCBs, dioxins, and furans. However, it should be noted that these contaminants bound to sediment particles can be resuspended during swimming and wading and, consequently, inadvertently ingested.

According to USEPA guidance (1989), exposure parameters used to estimate contaminant intakes for a given pathway should be selected so that the combination of all intake variables results in an estimate of the reasonable maximum exposure (RME) for that pathway. Standard default assumptions were used to estimate chemical intakes for each route of exposure (EPA 1989, 1991a, and 1991b).

It should be noted that a detailed review of the AGM HHRA indicated the AK Steel report is based on a relatively brief, unconfirmed "Human Use Survey" (HUS) of exposure in areas of Dick's Creek. A major flaw in the approach is an over-reliance on the results to develop "site-specific" exposure parameters, which were used to estimate the chemical dose, or average daily intake. At best, the HUS can be considered a snapshot of *current* human activity and may or may not accurately reflect current conditions, or future exposure conditions. Furthermore, the results should only be used to *qualitatively* evaluate current exposure conditions or to estimate the lower end of the range of potential risks. It cannot be used to evaluate future exposure conditions in estimating future risks because AK Steel has no means to legally enforce that current exposure conditions are maintained in perpetuity or at least until PCB levels attenuate to levels that will not pose unacceptable risks. Furthermore, the HUS was conducted while an advisory was in place cautioning "UNSAFE WATER, DO NOT SWIM, BATHE, DRINK, OR FISH," which could temporarily attenuate exposures (indicated in some survey results), but human nature may propel nearby residents to ignore such warnings. Indeed, on a recent site visit to the Dick's Creek areas, evidence of numerous exposures were observed that were in clear violation of posted warnings. According to USEPA (1994), risk assessments should not be conducted under the assumption institutional controls will be heeded:

> *"The cumulative site baseline risk should include all media that the reasonable maximum exposure scenario indicates are appropriate to combine and should not assume that institutional controls or fences will account for risk reduction."*

Furthermore, PCBs are highly resistant to natural degradation (particularly the more highly chlorinated PCBs) and will persist for many decades, which could outlast the usefulness of the institutional controls (which individuals already appear to ignore) or the ability of AK Steel to enforce the institutional controls now in place. Also, various deficiencies and irregularities were noted in the field notes of the HUS— such as limitations regarding the ability to identify repeat recreational individuals—that make the results of the HUS at Dick's Creek unreliable.

2.5 TOXICITY ASSESSMENT

The toxicological evaluation of AK Steel contaminants must focus on two groups of chemicals, namely, non-dioxin like PCB congeners and dioxin-like PCB, dioxin, and furan congeners. The toxicity of both these groups of chemicals are well understood, with thousands of peer-reviewed scientific studies published.

Overall Toxicity of PCB Mixtures

Although 12 PCB congeners of the 209 possible PCB congeners produce specific dioxin-like toxicity, the remaining PCB congeners produce non-dioxin-like effects. Human exposure to PCBs has occurred in the workplace and in numerous poisoning episodes of the general population. For example, many Japanese citizens were poisoned in an incident that occurred in 1968 resulting from the accidental ingestion of PCB-contaminated rice oil. Studies showed that the most notable toxic symptoms included dark brown pigmentation of nails and skin, chloracne (acne-like eruptions of the skin), increased eye discharge, increased sweating at the palms, and feeling of weakness.

Another massive poisoning occurred in China in 1979, where more than 2,000 people who ingested cooking rice oil contaminated with PCBs were affected. These individuals suffered liver damage and hepatomegaly (abnormal enlargement of the liver). The disease was especially severe in nursing children who were breast-fed or suffered fetal exposure *in utero* via exposed mothers. Developmental abnormalities have been observed in the brains (larger frontal and occipital fontanelles) of PCB-intoxicated infants. A significant correlation was found between plasma levels of PCBs in mothers occupationally exposed to PCBs in the workplace and the PCB levels in breast milk. It has been observed that, if these mothers nursed their babies for more than three months, the PCB levels in the infants exceeded those of their mothers and were subsequently retained in the children for many years.

PCB-induced Carcinogenicity

USEPA (IRIS 2003) classifies total PCBs as B2, or probable human carcinogens in humans. PCBs have been shown to produce cancer in the livers of laboratory animals.

Unlike conventional risk assessments, where specific toxicity values are developed for individual chemicals, Aroclors are complex mixtures that, once released into the environment, partition into different environmental media according to the physical-chemical properties of each PCB congener. That is, partitioning refers to processes in which different congeners fractionate or separate into water, sediment, and biological systems such as fish. In general, more toxic PCBs that are more highly chlorinated become concentrated into media with high organic content (such as sediments and fish) and, conversely, congeners with low chlorine content tend to be more volatile and also more soluble in water. USEPA PCB risk assessment methodology (USEPA 1996) is based on this partitioning phenomena, which distinguishes PCB mixtures by using environmental information on partitioning of congeners in fate and transport processes. Partitioning has profound effects that ultimately decrease or increase PCB toxicity in an individual medium, so the toxicity of an environmental mixture is only partly determined by the original commercial Aroclor mixture. A PCB HHRA, therefore, requires a tiered approach where the toxicity value used is dependent on the environmental medium and exposure pathway, rather than the Aroclor that is detected in the medium. As indicated in Exhibit 22, the highest observed potency from these ranges is appropriate for food chain exposure, sediment or soil ingestion, and dust or aerosol inhalation—pathways where environmental processes tend to increase risk. Lower potencies are appropriate for ingestion of water-soluble congeners or inhalation of evaporated congeners—pathways where environmental processes tend to decrease risk. To the extent that drinking water or ambient air contains contaminated sediment or dust, the higher potency values would be appropriate, as congeners adsorbed to sediment or dust tend to be of high chlorine content and persistence, especially for sediment or dust with high organic content.

EXHIBIT 22

TIERS OF HUMAN CANCER SLOPE FACTORS FOR ENVIRONMENTAL PCB MIXTURES BASED ON EXPOSURE ROUTES

HIGH RISK AND PERSISTENCE				
ED10	**LED10**	**Central Slope Factor**	**Upper-Bound Slope Factor**	**Exposure Pathways**
0.086	0.067	1	2	Food chain exposure Sediment or soil ingestion Dust or aerosol inhalation Dermal exposure, if an absorption factor has been applied to reduce the external dose Presence of dioxin-like, tumor-promoting, or persistent congeners in other media Early life exposure (all pathways and mixtures)
LOW RISK AND PERSISTENCE				
ED10	**LED10**	**Central Slope Factor**	**Upper-Bound Slope Factor**	**Exposure Pathways**
0.38	0.27	0.3	0.4	Ingestion of water-soluble congeners Inhalation of evaporated congeners Dermal exposure, if no absorption factor has been applied to reduce the external dose
LOWEST RISK AND PERSISTENCE				
ED10	**LED10**	**Central Slope Factor**	**Upper-Bound Slope Factor**	**Exposure Pathways**
2.4	1.4	0.04	0.07	Congener or isomer analyses verify that congeners with more than 4 chlorines constitute less than 0.5% of total PCBs

Notes: ED10 = Estimated dose associated with 10% increased incidence, in mg/kg-d;

LED10 = 95% lower bound on ED10, in mg/kg-d;

Central Slope = per mg/kg-d, computed as 0.10/ED10 and rounded to one significant digit;

Upper-Bound Slope = per mg/kg-d, computed as 0.10/LED10 and rounded to one significant digit.

The last departure from the conventional risk assessment approach for single chemicals is the use of central-estimate slope factors in PCB risk assessments. These are derived by linear extrapolation from ED10s, which can be described by a similar range with three reference points. Central-estimate slope factors are used to estimate a typical individual's risk, while upper bound slope factors assure that this risk is not likely to be underestimated if the underlying model is correct. In this HHRA, both central tendency exposure (CTE) and RME risks were calculated with both upper bound and central tendency slope factors based on the total PCB concentrations.

It should be stressed that commercial Aroclors tested in laboratory animals for the inherent toxicity of each Aroclor mixture were not subject to prior selective retention of persistent congeners through the food chain. This is important because bioaccumulated PCBs, such as those ingested through the fish ingestion pathway, appear to be more toxic than commercial PCBs and are more persistent in the body (USEPA 1996). In addition, because PCBs persist for a long period in the body, they provide a continuing source of internal exposure after external exposure stops. There may be greater-than-proportional effects from less-than-lifetime exposure, especially for persistent mixtures and for early-life exposures.

No effort was made in this HHRA to specifically evaluate sensitive populations for whom the risk estimates may be higher. These individuals would include nursing infants, particularly in those families who consume fish from Dick's Creek, as well as those with decreased liver function (USEPA 1996). In early-life exposure, infants can be highly exposed to PCBs during pregnancy and lactation (Dewailly *et al.* 1991, 1994). The accumulation of PCBs in human adipose tissue creates a store for subsequent release of PCBs into the bloodstream and then into the fetal circulation. During the postpartum period, PCBs are mobilized from adipose stores, transferred into human milk, and delivered to the neonate via nursing. This source of exposure may account for a substantial fraction of PCBs. USEPA suggests that an assessment be made of the extent of exposure through the human milk pathway; if direct measurement of concentrations in milk are not available, estimates can be derived from modeling maternal-to-infant exposures (Smith 1987). However, the constraints of this study did not allow such an analysis.

As mentioned previously, one of the most significant omissions in the comprehensive database is the absence of dioxin-like PCB congeners. A small group of 12 PCB congeners produce dioxin-like effects. These dioxin-like effects are toxicologically identical to dioxin (TCDD) itself, which USEPA (1996) considers to be highly toxic and carcinogenic:

> *"When assessing PCB mixtures, it is important to recognize that both dioxin-like and nondioxin-like modes of action contribute to overall PCB toxicity (Safe, 1994; McFarland*

and Clarke, 1989; Birnbaum and DeVito, in press). Because relatively few PCB congeners are dioxin-like, dioxin equivalence explains only part of a PCB mixture's toxicity."

Like USEPA, the National Academy of Sciences, NRC (NRC 2001) strongly emphasizes the need for analyzing for PCB congeners to calculate risks associated with dioxin-like PCBs, stating:

"The non- and mono-ortho-substituted PCBs are of particular concern, because these congeners can assume a planar or nearly planar conformation similar to that of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) (Safe 1990; Giesy et al. 1994a; Metcalfe and Haffner 1995) and have toxic effects similar to TCDD."

At many hazardous waste sites, the human health risks associated with dioxin-like PCB congeners are significantly greater and of much greater health concern than those presented by nondioxin-like PCBs. USEPA provides a case example of this in its PCB risk assessment guidance (USEPA 1996) and has also developed a protocol for quantifying the risks based on TEQs:

"When assessing mixtures of dioxin and related compounds, it is important to consider the contribution of dioxin-like PCBs to total dioxin equivalents (USEPA, 1994b). TEQs for dioxin-like PCBs (Ahlborg et al., 1994) can be added to those for other dioxin-like compounds. In some situations, PCBs can contribute more dioxin-like toxicity than chlorinated dibenzo-p-dioxins and dibenzofurans (Schecter et al., 1994; Dewailly et al. 1991, 1994). The congener 2,4,5,3',4'-pentachlorobiphenyl, shown to have tumor-promoting activity, is a major contributor to total dioxin equivalents in the United States (Patterson et. al., 1994) and maritime Quebec (Dewailly et al. 1994)."

PCBs are well absorbed from the gastrointestinal tract, skin, and lungs. PCBs initially concentrate in the liver, blood, and muscle, but are soon sequestered into fat tissue, where they have a long half life, typically on the order of decades. PCBs are metabolized to biphenyls, biphenyldiols, and dihydrodihydroxybiphenyls, and are ultimately excreted in urine and feces. Although there are species variations, the more highly chlorinated compounds are excreted more in the feces and are less readily metabolized than are less-chlorinated isomers.

Animal studies reveal a considerable variation in equipotent doses between species of both animals and PCBs. In comparable studies, however, the more chlorinated mixtures are more toxic than the less chlorinated ones. This trend predominantly holds between LD50 and carcinogenicity studies.

In humans, the primary acute toxic effect of PCBs is chloracne. Chronic ingestion of PCBs causes "Yusho Disease," named after the town of Yusho, Japan, where an epidemic occurred when residents ate PCB-contaminated food for several months. Chloracne develops after a latent period, along with pigmentation of skin areas, visual disturbances, gastrointestinal distress, jaundice, and lethargy. Infants from exposed mothers had low birth weight and pigment blotches. Some of these effects, however, have been ascribed to the chemically related polychlorinated dibenzofurans (PCDFs), which are byproducts found in most complex mixtures of PCBs. Industrial exposure, which is generally limited to dermal contact, produces chloracne and, in severe cases, hepatotoxicity. PCBs produce reproductive toxicity based on results of the few animal studies; the Yusho incident; and, more recently, a similar incident in Taiwan.

PCBs are class B2, or probable human carcinogens, based on the induction of liver tumors in experimental animals (EPA 1995).

Toxicity of Dioxin-like PCB, Dioxin, and Furan Congeners

Once released into the environment, some dioxin-like PCB congeners remain unaltered for more than 100 years. Likewise, dioxin absorbed into the body (and stored in body fat) will remain in the body for decades. It has been estimated that the amount of time it takes for the body to eliminate one-half the amount dioxin in the body is approximately 11 years.

The term “dioxin” refers to a group of compounds that are structurally similar; act through the same mechanism of toxicity; and, ultimately, produce similar toxic effects. The toxic effects of all dioxin-like PCB congeners are mediated through the so called “Ah receptor” (Ah-R). The Ah receptor is located in many cells in the body and is responsible for modulating the toxic response of dioxin-like chemicals. Indeed, the potency of a particular dioxin-like chemical is dependent on how tightly it binds to the Ah receptor. All dioxin-like responses are mediated through the Ah receptor and are termed “Ah-R mediated toxic effects.

The group of dioxin-like compounds consists of seven individual polychlorinated dibenzodioxin congeners (out of a total of 75 possible individual congeners), 10 PCDFs (out of a total of 135 congeners), and 12 polychlorinated biphenyls (out of a total of 209 PBC congeners), which have all been analyzed for in sediments, soil, and fish at the AK Steel facility. In total, there are 29 dioxin-like individual compounds (or congeners) that are structurally similar to the archetypical dioxin, 2,3,7,8-TCDD. The inherent systemic toxicity and carcinogenic potential of dioxin-like compounds is based on a toxicity equivalency paradigm where each individual dioxin-like congener is assigned a TEF based on the congener’s relative toxicity as compared with TCDD. As presented in previous tables, TCDD is the most toxic congener and, accordingly, is assigned a TEF of 1.0. All other congeners have slightly lower TEF values, ranging from 0.5 to 0.00001.

This toxicity ranking scheme has been internationally endorsed and is generally universally accepted by all toxicologists (USEPA 1989; Van den Berg 1998; Ahlborg *et al.* 1994).

Systemic Toxic Effects of Dioxin-Like PCB Congeners

Dioxin-like compounds damage many parts of the immune system and have been shown to be highly potent immunotoxins. Numerous studies have shown that individuals accidentally or occupationally exposed to dioxins-like compounds have more skin and respiratory system infections, and middle ear infections. In Germany, workers exposed to high levels of dioxin-like compounds had reduced T-cell activities; higher levels of IgA, IgG, IgM, and complement; and impaired immune responses. Air Force servicemen who sprayed the defoliant known as "Agent Orange," which contained TCDD as a contaminant, showed a correlation between IgA and serum dioxin levels. It has been suggested that this rise in IgA is consistent with a subclinical inflammatory response of unknown origin. Children in Taiwan who were exposed to dioxin-contaminated rice oil had several functional alterations in their immune systems. In Seveso, Italy, where residents were exposed to dioxin after a manufacturing plant explosion, children had higher levels of complement activity, higher lymphocyte responses to antigens, and increased numbers of peripheral lymphocytes.

The thymus gland, which is a central component of the immune system, has been shown to undergo dramatic shrinking in young animals after dioxin exposure. Dioxin also suppresses the immune system, compromising resistance to infections and cancers. For example, mice infected with influenza die at a higher rate if they are first exposed to a single dose of as little as 10 ng of dioxin per kg of body weight, which is a minuscule dose.

Dioxin-induced Diabetes

Diabetes mellitus is a class of diseases characterized by high levels of blood glucose resulting from defects in insulin production, insulin action, or both. Diabetes can provoke numerous pathological sequalae with numerous serious medical complications and premature death. Dioxins have been shown to induce Type 2 diabetes (which was previously called non-insulin-dependent diabetes mellitus or adult-onset diabetes and accounts for about 90% to 95% of all diagnosed cases of diabetes), which usually begins as insulin resistance, a disorder in which the cells do not use insulin properly. As the need for insulin rises, the pancreas gradually loses its ability to produce insulin. Type 2 diabetes impairs glucose tolerance and fasting glucose levels. Dioxin has been shown to interfere with insulin, alter glucose tolerance, and produce diabetes. Studies have shown that 50% of workers exposed to dioxin and evaluated 10 years after exposure were diabetic (or showed signs of pre-diabetes). Other research has found the risk of diabetes increases 12% for every 100 picograms dioxin/gram (pg/g) of lipid in the blood.

In 2001, the National Academy of Sciences (NAS), Institute of Medicine, concluded that there is strong evidence of an association between exposure to dioxin and Type 2 (adult-onset) diabetes. It has been found that veterans with blood dioxin greater than 33.3 pg/g have a relative risk (RR) of 2.5 for diabetes (the relative risk is the prevalence of the effect in the study group divided by the prevalence in the control group). It has also been found that veterans exposed to dioxin have a RR of 1.4 for glucose abnormalities, 1.5 for diabetes, and 2.3 for the use of oral medications to control diabetes. In addition, veterans exposed to dioxin develop diabetes earlier than other veterans, and non-diabetic veterans exposed to dioxin in Agent Orange have insulin abnormalities. Additionally, researchers have found that the Seveso residents had a significant increase in mortality from diabetes. It is important to note that diabetes can lead to:

- Blindness;
- Kidney Disease;
- Nerve Disease;
- Blood Circulation Disorders; and
- Heart Disease and Stroke.

Other Systemic Dioxin Toxicity

Dioxin also produces pathological changes in the skin, the liver, the thyroid gland, the endocrine system, the heart, and the lungs. Valuable toxicity information regarding human health effects has accrued through studies on individuals exposed to Agent Orange. The U.S. Air Force has funded more than 100 studies to investigate various toxic effects reported by exposed servicemen. These studies, referred to as the "Ranch Hands" studies, showed that Agent Orange (which is a herbicide mixture containing equal amounts of the two active ingredients, 2,4-D and 2,4,5-T, and contaminated with dioxin that was used in Vietnam) produced type 2 (adult-onset) diabetes and acute myelogenous leukemia (AML) in children of veterans who had returned to the United States. AML is a cancer of the bone marrow cells that generate white blood cells of the immune system that are responsible for preventing cancer. Studies also found dioxin causes soft-tissue sarcomas (cancers), non-Hodgkin's lymphoma, Hodgkin's disease, and chloracne.

Additional studies have found evidence of an association for three other cancers of the respiratory tract (larynx, lung or bronchus, and trachea), prostate cancer, multiple myeloma, and cardiovascular disease. An increase in spina bifida in the children of veterans, as well as acute and subacute (transient) peripheral neuropathy, and porphyria cutanea tarda (or PCT) were also observed.

Dioxin-induced Cancer

Various agencies and scientific organizations have recently reported their conclusions based on a review of the extensive toxicological database that dioxin (and related dioxin-like PCB congeners) is a potent human carcinogen. In 2001, the Department of Human Health Services, National Toxicology Program (NTP), upgraded the carcinogenic classification of dioxin from *Reasonably Anticipated to Be a Carcinogen* to a *Known Human Carcinogen*. In 1982, the International Agency for Research on Cancer (IARC) has also classified dioxin as a Group 1 or Human Carcinogen.

Several large studies have shown dioxin-induced cancer in humans as a result of occupational and environmental exposure. Researchers conducted a study in which 5,172 people who worked at 12 U.S. plants contaminated with dioxins were tracked for over 20 years. Men exposed for over one year had a 50% increase in stomach cancer, lung cancer, non-Hodgkin's lymphomas, Hodgkin's disease, and cancer of the soft and connective tissues. The relative risk for these cancers averaged 1.46. The largest relative risk was 9.2 for connective and soft-tissue cancers. It has been shown that exposed workers were more likely to die of all types of cancers combined than were unexposed workers, and that the risk correlated directly with the amount of exposure. In a separate analysis of 608 workers who had chloracne, the relative risk of death due to soft-tissue cancer was 11.32. Data were used to estimate lifetime cancer risk for a specific dose of TCDD. Several models were used to relate dose to total cancer mortality. The best fit to the data was a dose-response curve that was "concave" at low dose, and the lifetime risk for ingesting one picogram of TCDD per kilogram body weight per day was in the range of 1.2 x 10-3 to 7.7 x 10-3. This range is equivalent to a risk range of approximately 1 to 8 in 1,000 people.

National Academy of Sciences' Institute of Medicine officially released the fifth comprehensive report in a series entitled Veterans and Agent Orange on January 23, 2003. Based on the findings of this updated report, NAS concluded "sufficient evidence of an association" between the herbicides used in Vietnam and chronic lymphocytic leukemia (CLL). In response to this conclusion, Department of Veterans Affairs Secretary Anthony J. Principi has ordered the development of regulations that would add CLL to the list of illnesses presumptively recognized for service connection among Vietnam veterans (VA will be able to begin paying compensation benefits once the regulations are finalized later this year).

Highly Sensitive Individuals

Highly sensitive individuals include those already suffering from liver, skin, kidney, or respiratory disorders. Females who are pregnant or are of childbearing age are also at special risk. They should avoid dioxin exposure because a fetus or newborn exposed *in utero* and/or via breast milk is more acutely susceptible to dioxin-like toxic effects. Women of childbearing age, but not yet pregnant, may accumulate dioxin in fat stores that could affect the health of a fetus in a later pregnancy because the body burden (total amount stored in the body) of dioxin remains high long after exposure is terminated.

2.6 RISK CHARACTERIZATION

The final step in the HHRA is quantifying carcinogenic risks associated with exposure to total PCBs, dioxin-like PCB congeners, and dioxins and furans associated with AK Steel's uncontrolled releases of PCBs into Dick's Creek and its tributaries. This step involves integrating the results of the data assessment, exposure assessment, and toxicity assessment presented in the preceding sections. In the first step toward quantifying risk, PCBs in sediments, soils, and fish are organized into the AK Steel AOCs 1 and 2 for each individual exposure pathway. This step is carried out for child (1 to 6 years) and adult exposures. Risks for these three age groups are calculated and the overall risks for current and hypothetical future recreational receptors are summed individually for residential exposures along AK Steel AOC-1 and AOC-2.

Risks associated with exposure to potential human carcinogens are estimated as the incremental probability of an individual developing cancer over a lifetime (even though the exposure duration is only 30 years while at the same residence) as a direct result of exposure to a chemical (EPA 1989). The estimated risk is expressed as a unitless probability. For instance, a probability of 1E-4 represents the likelihood of 1-in-10,000 developing cancer during a 70-year lifetime as a result of the defined exposure conditions when exposed to the chemical over a 30-year exposure period.

It should be noted that, although the contaminants at the AK Steel facility may also cause severe non-carcinogenic toxic effects, such as diabetes and liver disease, as was discussed in the previous section, USEPA has not developed non-cancer toxicity values for PCBs or dioxins that can be used to quantify the magnitude of non-cancer health effects. Nevertheless, non-cancer toxicity is a concern and should not be ignored in protecting public health. However, if remediation of Dick's Creek is conducted based on the high cancer risk, that action will have the effect of mitigating non-cancer health effects as well.

Based on current census data, the mean and upper 95th percentiles for a resident staying in the same home are 9 years and 30 years, respectively. Likewise, it is assumed that a receptor who resides near Dick's Creek will frequently be exposed (due to its close proximity–within walking distance) to Dick's Creek and its tributaries over the period the receptor lives in the same home. For this reason, it is assumed that a lifetime exposure for a resident could begin with childhood exposures, with the person continually exposed as he or she continues to live in the community and mature into adulthood. It is also assumed that recreational fisherman do not catch fish and selfishly prepare and consume them alone, but take their catch and share it with their families, which may include children, pregnant women, and women of childbearing age.

The calculated cancer risk is presented in Exhibits 23 through 34. They are presented separately for each contaminant so that the relative contribution to the overall risk can be easily understood. Both *Reasonable Maximum Exposure* (RME) and *Central Tendency Exposure* (CTE) risks are presented for comparison. However, it should be noted that USEPA risk management policy is to rely on the more health-protective RME risk estimates when protecting public health.

The following exhibits present the cancer risks and are organized by contaminants detected in AK Steel AOCs 1 and 2:

AK Steel AOC-1

- Exhibit 23: Total PCB RME risks for AK Steel AOC-1
- Exhibit 24: Dioxin-like PCB RME risks for AK Steel AOC-1
- Exhibit 25: Dioxin and furan RME risks for AK Steel AOC-1
- Exhibit 26: Total PCB CTE risks for AK Steel AOC-1
- Exhibit 27: Dioxin-like PCB CTE risks for AK Steel AOC-1
- Exhibit 28: Dioxin and furan CTE risks for AK Steel AOC-1

AK Steel AOC-2

- Exhibit 29: Total PCB RME risks for AK Steel AOC-2
- Exhibit 30: Dioxin-like PCB RME risks for AK Steel AOC-2
- Exhibit 31: Dioxin and furan RME risks for AK Steel AOC-2
- Exhibit 32: Total PCB CTE risks for AK Steel AOC-2
- Exhibit 33: Dioxin-like PCB CTE risks for AK Steel AOC-2
- Exhibit 34: Dioxin and furan CTE risks for AK Steel AOC-2

Other exhibits include the following:

- Exhibit 34: Total Risks AOC-1
- Exhibit 35: Total Risks AOC-2
- Exhibit 36: Total Risks For Subsistence Fisherman AOC-1
- Exhibit 37: Total Risks For Subsistence Fisherman AOC-2

EXHIBIT 23

TOTAL PCBs: RME RISKS FOR AOC-1

Receptor	Exposure Pathway	Carcinogenic Risk
		RME
Adult Recreational Receptor	Sediment ingestion	1.20e-06
	Sediment dermal contact	6.30e-05
	Fish Ingestion	3.40e-04
	Cumulative total	4.04e-04
Child Recreational Receptor (1 to 6)	Sediment ingestion	2.70e-06
	Sediment dermal contact	5.10e-07
	Fish Ingestion	2.10e-04
	Cumulative total	2.13e-04
Total Recreational Risks		**6.17e-04**

EXHIBIT 24

DIOXIN-LIKE PCBs: RME RISKS FOR AOC-1

Receptor	Exposure Pathway	Carcinogenic Risk
		RME
Adult Recreational Receptor	Sediment ingestion	1.40e-06
	Sediment dermal contact	7.70e-05
	Fish Ingestion	1.30e-03
	Cumulative total	1.38e-03
Child Recreational Receptor (1 to 6)	Sediment ingestion	6.30e-07
	Sediment dermal contact	1.20e-07
	Fish Ingestion	1.20e-05
	Cumulative total	1.28e-05
Total Recreational Risks		**1.39e-03**

EXHIBIT 25

DIOXIN AND FURANs: RME RISKS FOR AOC-1

Receptor	Exposure Pathway	Carcinogenic Risk
		RME
Adult Recreational Receptor	Sediment ingestion	2.70e-07
	Sediment dermal contact	1.50e-05
	Fish Ingestion	2.00e-05
	Cumulative total	3.53e-05
Child Recreational Receptor (1 to 6)	Sediment ingestion	6.30e-07
	Sediment dermal contact	1.20e-07
	Fish Ingestion	1.20e-05
	Cumulative total	1.28e-05
Total Recreational Risks		**4.80e-05**

EXHIBIT 26

TOTAL PCBs: CTE RISKS FOR AOC-1

Receptor	Exposure Pathway	Carcinogenic Risk
		CTE
Adult Recreational Receptor	Sediment ingestion	2.30e-08
	Sediment dermal contact	2.80e-06
	Fish Ingestion	1.30e-06
	Cumulative total	4.12e-06
Child Recreational Receptor (1 to 6)	Sediment ingestion	6.00e-08
	Sediment dermal contact	2.50e-08
	Fish Ingestion	1.00e-05
	Cumulative total	1.01e-05
Total Recreational Risks		**1.42e-05**

EXHIBIT 27

DIOXIN-LIKE PCBs: CTE RISKS FOR AOC-1

Receptor	Exposure Pathway	Carcinogenic Risk
		CTE
Adult Recreational Receptor	Sediment ingestion	5.40e-08
	Sediment dermal contact	6.70e-06
	Fish Ingestion	9.20e-06
	Cumulative total	1.59e-05
Child Recreational Receptor (1 to 6)	Sediment ingestion	1.50e-07
	Sediment dermal contact	6.10e-08
	Fish Ingestion	7.30e-06
	Cumulative total	7.51e-06
Total Recreational Risks		**2.34e-05**

EXHIBIT 28

DIOXIN AND FURANs: CTE RISKS FOR AOC-1

Receptor	Exposure Pathway	Carcinogenic Risk
		CTE
Adult Recreational Receptor	Sediment ingestion	1.00e-08
	Sediment dermal contact	1.30e-06
	Fish Ingestion	1.50e-07
	Cumulative total	1.46e-06
Child Recreational Receptor (1 to 6)	Sediment ingestion	2.80e-08
	Sediment dermal contact	1.20e-08
	Fish Ingestion	1.20e-07
	Cumulative total	1.60e-07
Total Recreational Risks		**1.62e-06**

EXHIBIT 29

TOTAL PCBs: RME RISKS FOR AOC-2

Receptor	Exposure Pathway	Carcinogenic Risk
		RME
Adult Recreational Receptor	Sediment ingestion	1.00e-05
	Sediment dermal contact	5.60e-04
	Fish Ingestion	1.20e-04
	Cumulative total	6.90e-04
Child Recreational Receptor (1 to 6)	Sediment ingestion	2.40e-05
	Sediment dermal contact	4.50e-06
	Fish Ingestion	7.20e-05
	Cumulative total	5.29e-04
Total Recreational Risks		**1.22e-03**

EXHIBIT 30

DIOXIN-LIKE PCBs: RME RISKS FOR AOC-2

Receptor	Exposure Pathway	Carcinogenic Risk
		RME
Adult Recreational Receptor	Sediment ingestion	2.30e-05
	Sediment dermal contact	1.30e-03
	Fish Ingestion	9.00e-04
	Cumulative total	2.20e-03
Child Recreational Receptor (1 to 6)	Sediment ingestion	3.40e-06
	Sediment dermal contact	6.40e-07
	Fish Ingestion	4.20e-06
	Cumulative total	8.24e-06
Total Recreational Risks		**2.23e-03**

EXHIBIT 31

DIOXIN AND FURANs: RME RISKS FOR AOC-2

Receptor	**Exposure Pathway**	**Carcinogenic Risk**
		RME
Adult Recreational Receptor	Sediment ingestion	1.50e-06
	Sediment dermal contact	8.00e-05
	Fish Ingestion	7.10e-06
	Cumulative total	8.86e-05
Child Recreational Receptor (1 to 6)	Sediment ingestion	3.40e-06
	Sediment dermal contact	6.40e-07
	Fish Ingestion	4.20e-06
	Cumulative total	8.24e-06
Total Recreational Risks		**9.68e-05**

EXHIBIT 32

TOTAL PCBs: CTE RISKS FOR AOC-2

Receptor	**Exposure Pathway**	**Carcinogenic Risk**
		CTE
Adult Recreational Receptor	Sediment ingestion	2.00e-07
	Sediment dermal contact	2.40e-05
	Fish Ingestion	4.50e-07
	Cumulative total	2.47e-05
Child Recreational Receptor (1 to 6)	Sediment ingestion	5.30e-07
	Sediment dermal contact	2.20e-07
	Fish Ingestion	1.40e-06
	Cumulative total	2.15e-06
Total Recreational Risks		**2.68e-05**

EXHIBIT 33

DIOXIN-LIKE PCBs: CTE RISKS FOR AOC-2

Receptor	Exposure Pathway	Carcinogenic Risk
		CTE
Adult Recreational Receptor	Sediment ingestion	9.00e-07
	Sediment dermal contact	1.10e-04
	Fish Ingestion	6.80e-06
	Cumulative total	1.18e-04
Child Recreational Receptor (1 to 6)	Sediment ingestion	2.40e-06
	Sediment dermal contact	1.00e-06
	Fish Ingestion	2.00e-05
	Cumulative total	2.34e-05
Total Recreational Risks		**1.41e-04**

EXHIBIT 34

DIOXIN AND FURANs: CTE RISKS FOR AOC-2

Receptor	Exposure Pathway	Carcinogenic Risk
		CTE
Adult Recreational Receptor	Sediment ingestion	5.70e-08
	Sediment dermal contact	7.00e-06
	Fish Ingestion	5.30e-08
	Cumulative total	7.11e-06
Child Recreational Receptor (1 to 6)	Sediment ingestion	1.50e-07
	Sediment dermal contact	6.30e-08
	Fish Ingestion	1.60e-07
	Cumulative total	3.73e-07
Total Recreational Risks		**7.48e-06**

EXHIBIT 35

SUMMARY: TOTAL RISKS

FOR RECREATIONAL EXPOSURE IN AK STEEL AOC-1

Type of Risk	Risk
Total RME Risks for Recreational Exposure	3.77E-03
Total CTE Risks for Recreational Exposure	5.21E-05

EXHIBIT 36

SUMMARY: TOTAL RISKS

FOR RECREATIONAL EXPOSURE IN AK STEEL AOC-2

Type of Risk	Risk
Total RME Risks for Recreational Exposure	4.25E-03
Total CTE Risks for Recreational Exposure	1.59E-04

EXHIBIT 37

SUMMARY: REASONABLE MAXIMUM EXPOSURE (RME) RISKS

FOR SUBSISTENCE FISHERMEN

AK STEEL AOC-1

Receptor	Contaminant	Carcinogenic Risk
		RME
Subsistence Fisherman	Total PCBs	8.10e-04
	Dioxin-like PCBs	2.90e-03
	Dioxins and Furans	4.70e-05
Total Risks		**3.76e-03**

EXHIBIT 38

SUMMARY: REASONABLE MAXIMUM EXPOSURE (RME) RISKS

FOR SUBSISTENCE FISHERMEN

AK STEEL AOC-2

Receptor	Contaminant	Carcinogenic Risk
		RME
Subsistence Fisherman	Total PCBs	2.80e-04
	Dioxin-like PCBs	2.10e-03
	Dioxins and Furans	1.70e-06
Total Risks		**2.40e-03**

2.7 UNCERTAINTY ASSOCIATED WITH RISK ESTIMATES

The discussion of uncertainty is an important component of the risk assessment because there are varying degrees of uncertainty at each stage of the HHRA analysis. It should be first emphasized, that by the recent sampling investigation conducted by USEPA Region 5 where the archival Aroclor data set was supplemented with highly precise and accurate PCB congener data, USEPA has effectively eliminated a considerable amount of uncertainty that is routinely introduced by relying solely on Aroclor data at PCB-contaminated sites. Whereas the true magnitude of contamination and toxicity associated with PCB contamination is difficult to determine with Aroclor analysis, PCB congener analysis permits a toxicological evaluation to be conducted on both dioxin- and non-dioxin-like PCBs. PCB congener data also provide the necessary information to conduct a fingerprint analysis. Nevertheless, there remains some uncertainty about the cancer risk estimated in this HHRA. Underestimating risks could result from:

- The lack of congener-specific data on resuspended sediments in surface water that swimmers and/or waders could be exposed to during recreational activities;
- Unknown sources of PCBs yet to be identified in Dick's Creek and its tributaries;
- Not modeling potential risks to nursing infants who may be indirectly exposed through breast-feeding females;
- Underestimating the amount of time sensitive receptors may spend in recreational activities in Dick's Creek;
- Risks have only been estimated for carcinogenic effects and do not represent the threat to public health from medical conditions such as diabetes and reproductive effects; and
- Underestimating the consumption of fish caught by recreational fisherman and their families.

The following are the major potential sources that could result in an overestimation of risk:

- Overestimating the amount of fish consumed by individuals using or living in the area;
- Overestimating the amount of recreation time spent in AOC-1 and AOC-2;
- Overestimating the extent of contamination.

Other sources of uncertainty that would have uncertain consequences on the risk estimates include the following:

- Unknown differences between humans and laboratory animals with regard to the absorption, distribution, metabolism, excretion and overall toxicity of PCB congeners;

- Statistical models used to extrapolate from high to low doses in animal studies.

2.8 CONCLUSIONS

The conclusions from this HHRA regarding the source and responsibility of PCB contamination in Dick's Creek and its tributaries are as follows:

- The PCBs in AK Steel AOCs 1 and 2 are the result of uncontrolled releases by the AK Steel facility downstream from the vicinity of sample location S17;
- The PCB fingerprint in AK Steel AOCs 1 and 2 is a single fingerprint with no anomalous data suggesting the presence of a "third party" release;
- The PCB fingerprint in AK Steel AOCs 1 and 2 is significantly different from the background fingerprint based on samples collected upstream of sample location S17;
- The S30 sample which was collected at the terminus of AOC-1 (nearest the Great Miami River) has a significantly different fingerprint and *is* likely evidence of a third party release. This sample was identified as an outlier even though the concentration was very low.

The conclusions from this HHRA regarding the potential current and future human health risks associated with exposure to PCB contamination in Dick's Creek and its tributaries are as follows:

- The over-reliance on archival Aroclor data has significantly underestimated risk associated with uncontrolled release of PCBs into Dick's Creek and its tributaries;
- The human health risk for developing cancer for an individual using Dick's Creek and its tributaries within AK Steel AOCs 1 and 2 areas for routine recreational activities based on the recently generated PCB congener data is in excess of 1E-3 (or 1-in-1,000 excess lifetime cancer risk);
- The high cancer risk is far in excess of USEPA's *de minimus* risk level of 1E-6 and outside its discretionary risk range of 1E-6 to 1E-4 for human exposure;
- The greatest human health risk involves ingesting PCB-laden fish caught during routine recreational activities;
- Risks associated with dioxin and furan exposure are significantly less than dioxin-like PCB exposure.
- Dick's Creek and its tributaries should be remediated to levels that mitigate both current and future threats to public health.

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Appendix A

Statistical Fingerprinting: PCB, Dioxin, and Furan Mixtures in AK Steel AOCs and Background Sediments and Fish

Executive Summary

Polychlorinated biphenyls (PCBs) have been detected in high concentrations in Dick's Creek sediments, floodplain soil, and fish in AOCs 1 and 2 collectively referred to in this section as contaminated sediments.. As previously discussed, "PCBs" refer to a group of highly complex mixtures made up of 209 individual congeners. Although commercial PCB mixtures known as Aroclors have been relatively well characterized, once released into the environment, PCB mixtures undergo weathering that alters the original composition. Alterations in the original PCB mixture can be significant as the composition of the PCB mixture changes over time through partitioning, chemical transformation, and preferential bioaccumulation. In order to identify source areas and assign responsibility for the uncontrolled release of PCB at the AK Steel facility and to determine whether there may be a third party PCB release (not associated with the AK Steel facility) in surrounding areas, environmental PCB mixtures must be fingerprinted. Because the environmental PCB mixture has undergone weathering it will have a unique fingerprint that is dependent on the original composition of the PCB mixture and the degree of weathering the mixture has undergone.

A geostatistical approach has been developed to fingerprint PCB mixtures, as well as related dioxins and furans in Monroe Ditch and Dick's Creek sediments, floodplain soils, and fish. This method is based on well-developed linear regression/residual analysis statistical methods. The purpose of these methods are to quantify the strength of relationships between PCB congeners having the same physical-chemical properties. That is, PCB congeners with similar physical properties will move through the environment and partition in different environmental media, and degrade at similar rates resulting in the ***ratio*** of similar PCB congener pairs remaining constant as they migrate in the environment. That is, when released into Dick's Creek the ratio between similar congener pairs will remain constant while the absolute concentration of each congener will vary considerably from one sample location to the next. Third party sources are easily identified because they will have a unique fingerprint either because the original mixture was a different composition (i.e., different Aroclor) or it has undergone a more or less weathering.

It should be stressed that this fingerprint analysis was only made possible by USEPA's recent sampling effort in which USEPA Methods 1668 and 1613 were used to fully characterize all 209 PCB congeners and 17 dioxin and furan congeners, respectively. These high resolution methods are sensitive enough to detect these congeners at parts-per-quadrillion concentrations and allowed this fingerprint analysis to be conducted with high resolution.

Although the overall goal of the fingerprinting analysis is to determine if the AK Steel facility is responsible for the PCBs detected in Dick's Creek, as well as any dioxins and furans, the following step-wise approach was followed to develop a weight-of-evidence statistical conclusion:

- ***Step 1:*** Empirically identify a characteristic group of PCB congeners (with similar physical-chemical properties) to fingerprint;
- ***Step 2:*** Identify samples representing background and contaminated sediments in Dick's Creek and its tributaries representing uncontrolled AK Steel PCB releases.
- ***Step 3:*** Fingerprint PCB congeners in contaminated sediments;
- ***Step 4:*** Fingerprint dioxin and furan congeners in contaminated sediments;
- ***Step 5:*** Fingerprint PCB congeners in background area;
- ***Step 6:*** Fingerprint dioxin and furan congeners in background area;
- ***Step 7***: Conduct outlier analysis to determine if anomalous data (statistical outliers) are present in contaminated data set that could represent potential third party release(s);
- ***Step 8***: Compare fingerprints from contaminated and background sediments with regard to PCBs and dioxin-furan fingerprints to determine if fingerprints match.

Each fingerprint is based on more than 100 individual (statistical) points of comparison characteristics. These distinguishing points or characteristics are unique and very sensitive to any changes in the PCB congener composition. Where high correlations exist, the concentrations of dioxin-like PCBs are estimated based on the unique mathematical relationship defined with linear regression methods. This statistical approach is based on the well-known Spearman Rank Correlation method that is used to fingerprint complex mixtures by identifying highly correlated pairs of variables. It has been shown to be a highly effective tool for fingerprinting PCB congeners in blood (Volker D, Huber W, Bauer K, Suesal C, Conradt C, Opelz G. Environ Health Perspect. 2001 Feb;109(2):173-8.2001).

1. INTRODUCTION

1.1 Purpose

Statistical methods have been developed to create fingerprints for mixtures of polychlorinated biphenyls (PCBs), dioxins, and furans in sediments along Monroe Ditch and Dick's Creek downstream of the AK Steel facility. These methods are based on linear regression correlation and residual analysis, and are used to characterize a unique fingerprint for each sampling location to determine if downstream PCB mixtures are related to those in the source areas upstream at the AK Steel facility. The fingerprint of PCBs, dioxins, and furans in an environmental sample is based on the precise *ratio* between correlated congeners. Although the absolute concentrations of individual congeners are typically attenuated as the PCBs are transported downstream away from the original source, the ratio between highly correlated congener pairs (typically, those that share similar physical-chemical characteristics) are maintained (or conserved), regardless of the distance from the source area. That is, congener ratios are not confounded by distance from the source. Because physically similar congeners undergo weathering in a similar manner, the ratios should remain relatively constant in all samples sharing the fingerprint characteristics of the original source. For example, the fingerprint of a point PCB source identified near Monroe Ditch would be similar in all sample locations downstream. If the fingerprint of a source area in Monroe Ditch sediments revealed that two PCB congeners were present in source area samples in a mass ratio of 3:4, all samples collected downstream would have a mass ratio of 3:4, despite the fact that the concentration of the two individual congeners was significantly decreased downstream. This ratio would be conserved in all downstream samples regardless of dilution and weathering because congeners with similar physical-chemical characteristics (which are shared by the dioxin-like group of congeners) weather in a similar manner once released into the environment.

The purpose for developing this technical approach based on correlation linear regression is to first to identify statistically correlated congener pairs of PCBs, dioxins, and furans in different sample locations. For each sample location, the number and type of paired congeners reveal a unique pattern, which can be used to determine if contaminants detected at different locations are related. The advantages of this fingerprinting approach include the following:

- High sensitivity in matching similar PCB sources with downstream PCB fingerprints

- Identifying potential enrichment at downstream locations that have putatively been identified as other ubiquitous anthropogenic or third-party sources;

- Estimating dioxin-like congener concentrations at sample locations where only archival Aroclor data are currently available;

- Significant reduction in confounding factors typically introduced with conventional statistical methods;

- The ability to fingerprint PCB mixtures for a single sample.

Specific aspects within each of these three phases of the statistical investigation are outlined in Section 2.

2. STATISTICAL METHOD

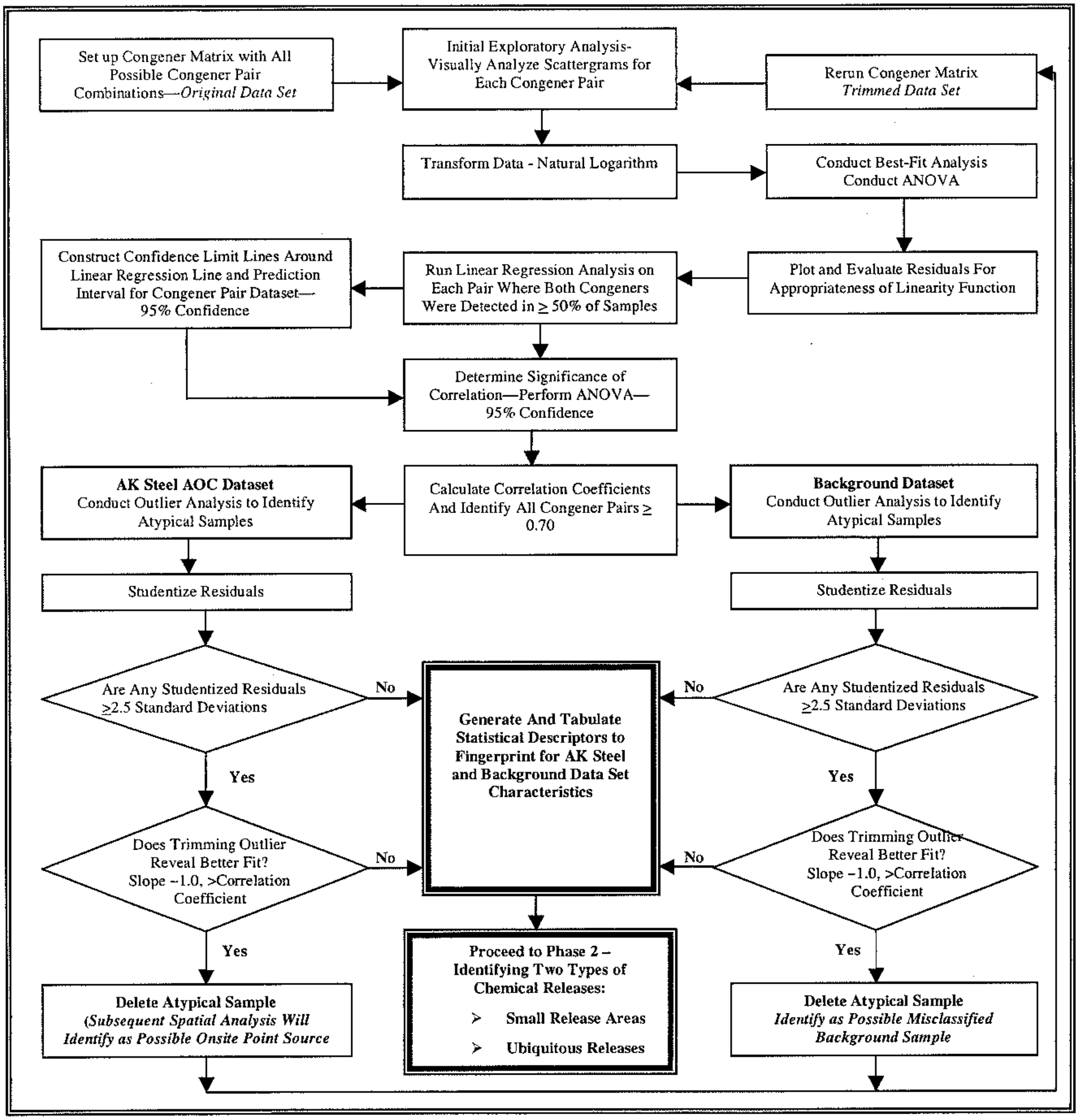
As indicated in Exhibit A-1, the analysis of congener fingerprints is conducted in three phases. The following sections provide brief technical details of each phase.

2.1 Phase 1: Fingerprint Characterization

There are numerous steps involved in fingerprinting complex environmental PCB mixtures for each sample location of interest. Exhibit A-1 presents the steps and decision criteria in characterizing PCB fingerprints based on relationships between congener pairs. The initial step is determining the total *number* of highly correlated congener pairs. The number of pairs is important because gross differences between two locations could indicate different fingerprints. It should be stressed that identifying a strong correlation between congeners is not accidental because the probability that two congeners are highly correlated simply by random error or chance is very low and is a first indication that a common source exists. Once highly correlated pairs are identified, the intrinsic relationship between them is further defined and used to develop a comprehensive fingerprint where outliers are identified and trimmed; associations between congeners are described mathematically, which includes determining the mass ratio for each correlated pair.

The following brief sections present, in step-wise detail, the fingerprinting procedure outlined in the flowchart in Exhibit A-1. These steps are first followed to characterize PCB congener fingerprints for the source area represented by the samples collected in the contaminated area. The same steps are be followed to fingerprint the background data set, which are those samples collected upstream of sample location S17, to determine whether they match the AK Steel source fingerprint.

EXHIBIT A-1
PHASE 1- QUANTIFYING CORRELATION RELATIONSHIPS BETWEEN CONGENER PAIRS: GENERATING FINGERPRINT INFORMATION



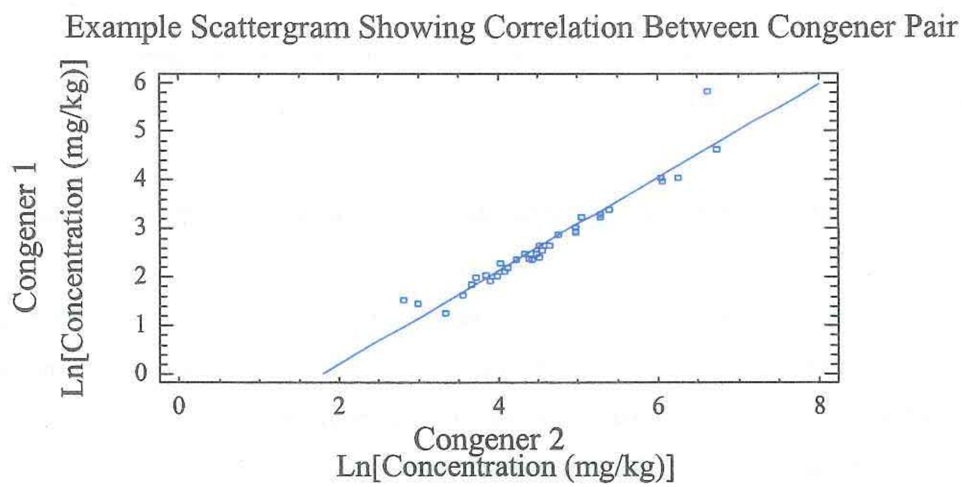
Step 1: Set up Congener Matrix with All Possible Congener Pair Combinations

Set up a congener matrix table for each permutation pair of PCB, dioxin, and furan congeners, and develop a numbering system to identify each congener pair.

Step 2: Prepare and Visually Inspect Scattergrams for Gross Differences Between Data Sets

Create and inspect each congener pair scattergram to identify obvious anomalies or unusual patterns as shown in Exhibit A-2. After careful evaluation, select only those congener pairs in which both congeners are detected (quantified) in more than three samples.

EXHIBIT A-2



Step 3: Conduct Best-Fit Analysis

Conduct empirical best-fit analyses for each congener pair by plotting transformed data. Data are transformed using the following transformation functions:

1. Exponential
2. Reciprocal-Y
3. Reciprocal-X
4. Double reciprocal
5. Logarithmic
6. Multiplicative
7. Square root-X
8. Square root-Y
9. Logistic
10. Log Probit.

The best-fit transformation is based on the highest r-squared value of the linear regression line. Typically, transforming data using the natural logarithm (Ln) function yields the best fit for environmental data sets. If this holds true, all data sets will be Ln-transformed, and subsequent statistical analysis is performed on transformed data.

Step 4*: *Run Linear Regression Analysis on Each Pair Where Both Congeners Were Detected in Four or More Samples

Run linear regression analysis for each congener pair in which both congeners have been quantified. Four samples is the *minimum* number of samples necessary to conduct linear regression analysis with confidence.

Step 5*: *Determine Significance of Correlation–Perform Analysis of Variance (ANOVA)–95 Percent Confidence.

Construct linear regression line and 95% confidence limit lines around the regression line, as well as 95% prediction limit lines.

Step 6*: *Calculate Correlation Coefficients and Identify All Congener Pairs Greater than or Equal to 0.70.

Calculate *strength* of correlation based on the correlation coefficient (r-value). It has been empirically determined that all congener pairs with $1.0 \geq r$-value ≥ 0.70 exhibit relatively strong correlations and represent a subset of congener pairs that can be used to fingerprint data sets. Exhibit A-3 shows a weak correlation between congener pairs while Exhibit A-4 shows a strong correlation.

EXHIBIT A-3

Example Linear Regression Plot Showing Weak Correlation: r = 0.37

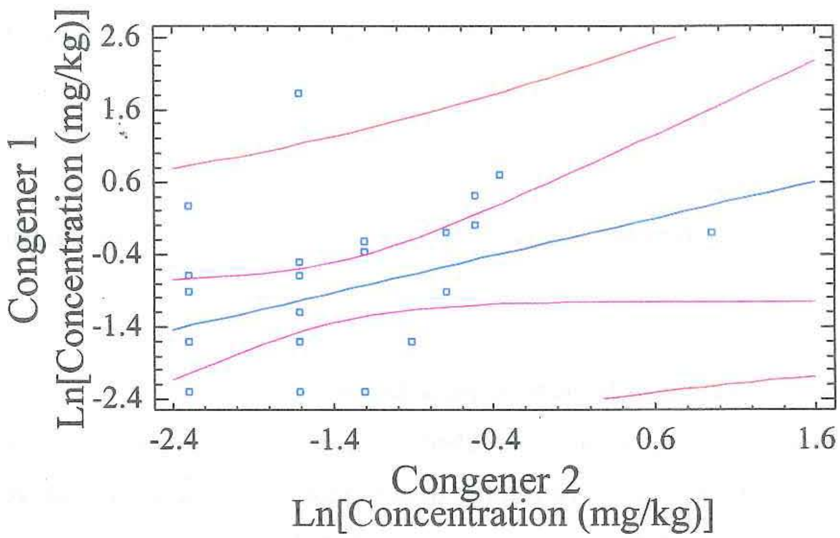
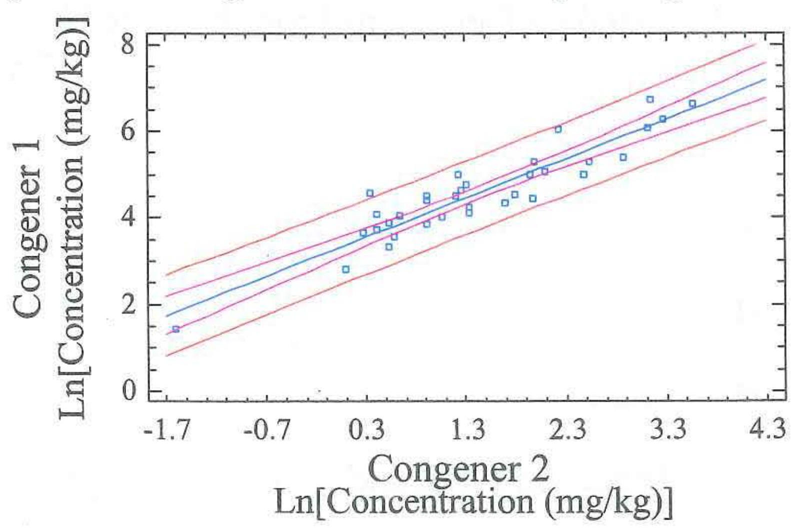


EXHIBIT A-4

Example Linear Regression Plot Showing Strong Correlation: r = 0.92



Step7: Evaluate significance

Evaluate *significance* of the association between each congener pair with ANOVA at a 95% confidence level by testing the Null Hypothesis: Slope $\neq 0$

It should be noted that, when the slope = 0, there is no significance relationship between the two congeners even though it is possible to have a high *r*-value (high correlation coefficient) when the correlation is not significant.

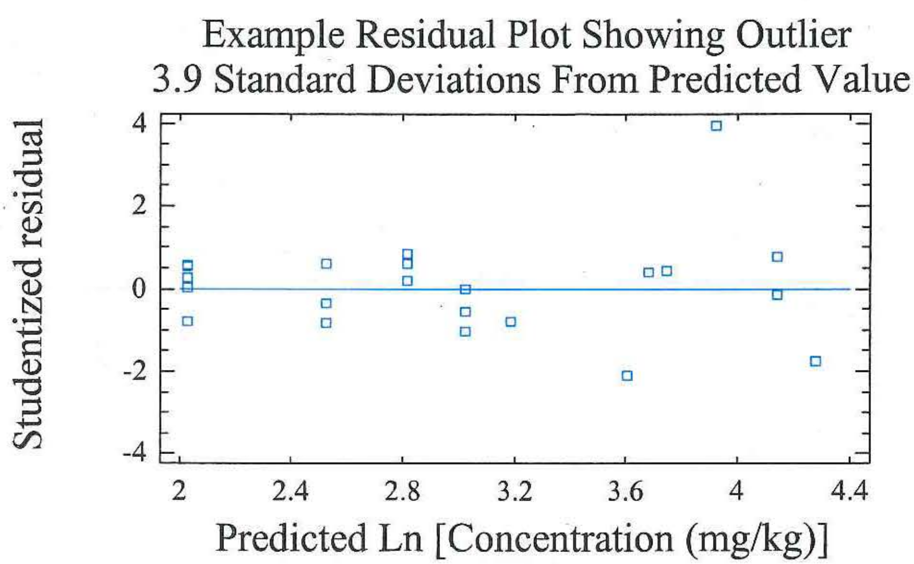
Step 8: Studentize Residuals

Calculate residuals (difference between observed and fitted value $e_i = Y_i - Y_{mean}$) and Studentize residuals ($e_i/[Mean\ Square\ Error]^{1/2}$).

Step 9: Conduct Outlier Analysis to Identify Atypical Samples

Conduct outlier analysis to identify possible "enriched" samples representing a third party release. Outliers are defined as "Studentized Residuals." To identify outliers representing spurious data, residuals are first generated (representing the error between observed and predicted mean value) and then normalized, or Studentized. Studentized Residuals greater than 2.5 standard deviations are considered outliers. Exhibit A-5 presents an example plot of how samples containing outliers or anomalous data are easily identified.

EXHIBIT A-5



Step 10: Does Trimming Outlier Reveal Better Fit? Slope~1.0, Greater than Correlation Coefficient

Evaluate whether trimming outlier(s) from the data set provides a better fit based on an increase in *r*-value and slope closer to 1.0. The final determination as to the elimination of an outlier is a two-step process based on empirical information. In the first step, the identified potential outlier is first eliminated and the trimmed linear regression plot regenerated. The second step is a comparison of the statistical descriptors generated in the original and trimmed data sets. The final determination as to whether the unusual point should be deleted is based on the following factors:

- Significant changes in the slope of the line: Data are not eliminated when the slope changed significantly from 1.0
- Significant changes in the r-value: Data are eliminated only when the r-value increased representing a better fit
- Significant changes in the fit of the line: Ln-transformed data remained the best fit.

Eliminating outliers, by definition, increases the *r*-value (correlation) between congener pairs. In some instances, the increase is dramatic. In other cases, eliminating an outlier without regard to other statistics significantly reduces the apparent correlation between congeners. In rare instances, a positive correlation is transformed into a negative correlation. Finally, if eliminating a potential outlier causes a fundamental change in the underlying distribution or shape of the fitted line, it is not eliminated. It should be noted that, after an outlier is identified, the sample is recorded to determine whether any spatial pattern exists to explain the outlier. Where a particular sample is repeatedly identified as containing outliers *and* a pattern is apparent for one or more congeners, it is identified as an atypical sample. The sensitivity of the technique allows even small deviations in a single sample to be identified.

Step 11: Delete Atypical Sample

If outliers are eliminated, steps 1-10 are repeated. The statistical process would be conducted again on the trimmed data set. This is necessary because not eliminating outliers from the data sets introduces an unacceptable confounding factor that cannot be controlled or measured in subsequent analytical steps.

Step 12: Generate and Tabulate Statistical Descriptors to Fingerprint Data Set Characteristics

Prepare descriptive statistical summary tables that represent a congener fingerprint for each data set. Tables present the following information (which is either the original data set with no outliers identified, or the trimmed data set with outliers eliminated):

11. Ranked correlation coefficients (for each of the congener pairs in each data set)
12. Number of highly correlated (r-value > 0.70) congener pairs
13. Correlation coefficient for original or trimmed data set
14. Y-intercept (anti-Ln) (represents mass ratio)
15. Y-intercept 95% confidence limits
16. Slope of linear regression equation
17. Linear regression equation.

2.2 Phase 2: Comparing AK Steel Source And Downstream PCB Fingerprints

Exhibits A-6-1 through A-6-5 present the steps in which the source fingerprint is compared with those fingerprints downstream. In this phase, the statistical descriptors are organized and compared. The critical points of comparisons for the two groups are as follows:

18. Number of correlated congener pairs
19. Number and pattern of outliers (representing atypical samples)
20. Number of identical correlated pair matches in source and downstream data sets
21. Number of correlated pair mismatches
22. Regression slopes
23. Y-intercepts, representing the mass ratio between congener pairs.

Exhibit A-6-1
Phase 2
Fingerprint Comparison Framework

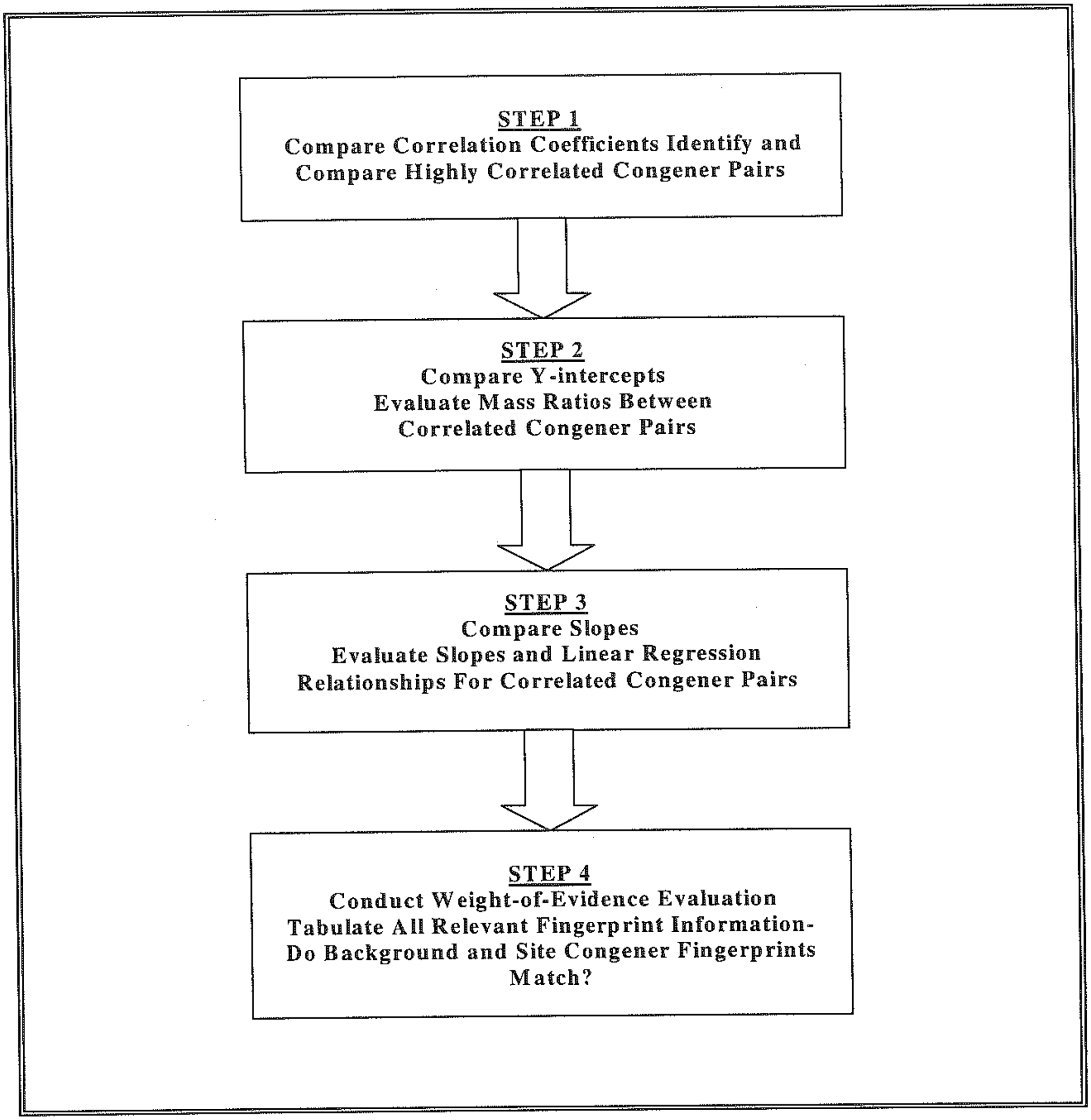


Exhibit A-6-2
Phase 2
Step1: Compare Correlation Coefficients

STEP 1
Compare Correlation Coefficients Identify and Compare Highly Correlated Congener Pairs

STEP 2
Compare Y-intercepts
Evaluate Mass Ratios Between Correlated Congener Pairs

STEP 3
Compare Slopes
Evaluate Slopes and Linear Regression Relationships For Correlated Congener Pairs

STEP 4
Conduct Weight-of-Evidence Evaluation
Tabulate All Relevant Fingerprint Information-
Do Background and Site Congener Fingerprints Match?

STEP 1 - Compare Correlation Coefficients

Purpose:

Identify individual highly correlated dioxin congers in the background reference area. Determine whether the same pairs are highly correlated in the onsite dataset. Determine whether the rank order of correlation coefficients in onsite dataset closely matches background dataset.

Activities:

Direct Comparisons

- Compare number of highly correlated congener pairs (correlation coefficient > 0.70) in background and onsite datasets
- Identify individual highly correlated congener pairs in background dataset that are not present in site dataset
- Identify individual highly correlated congener pairs in background dataset that are not present in site dataset
- Identify potential outliers-conduct spatial analysis (same sample) to determine whether correlation coefficients increase with trimming
- Compare and document those correlation coefficients that are similar in the two groups

Statistical Comparisons

Exhibit A-6-3
Phase 2
Step2: Compare Y-intercepts

STEP 1
Compare Correlation Coefficients Identify and Compare Highly Correlated Congener Pairs

STEP 2
Compare Y-intercepts
Evaluate Mass Ratios Between Correlated Congener Pairs

STEP 3
Compare Slopes
Evaluate Slopes and Linear Regression Relationships For Correlated Congener Pairs

STEP 4
Conduct Weight-of-Evidence Evaluation
Tabulate All Relevant Fingerprint Information-
Do Background and Site Congener Fingerprints Match?

STEP 2 - Compare Y-intercepts

Purpose:

The Y-intercept on the linear regression line represents the mass *ratio* between two highly correlated congeners. This ratio should be conserved (remain constant) in each sample collected from the background region. Likewise, the same mass ratios should be conserved in all onsite samples (with similar historical use) that have not been impacted by an onsite release. A conservation of a mass *ratio* in background and onsite datasets strongly indicates no dioxin congeners have been added to the site.

Activities:

Direct Comparisons

- Compare the y-intercepts for highly correlated pairs
- Number of matches between background and onsite Y-intercepts for highly (based on 95% confidence limits)
- Identify specific congener pairs that have different mass ratios
- Identify samples that are potential outliers representing point sources
- Estimate the concentration of point-release based on an analysis of residuals

Statistical Comparisons

Determine if there are statistical differences between standardized mass ratios of background and site datasets at the 95 percent confidence level (i.e. Wilcoxon-Rank Sum test)

Exhibit A-6-4
Phase 2
Step 3: Compare Slopes

STEP 1
Compare Correlation Coefficients Identify and Compare Highly Correlated Congener Pairs

↓

STEP 2
Compare Y-intercepts
Evaluate Mass Ratios Between Correlated Congener Pairs

↓

STEP 3
Compare Slopes
Evaluate Slopes and Linear Regression Relationships For Correlated Congener Pairs

↓

STEP 4
Conduct Weight-of-Evidence Evaluation
Tabulate All Relevant Fingerprint Information-
Do Background and Site Congener Fingerprints Match?

STEP 3 - Compare Slopes

Purpose:

Compare slopes of highly correlated congeners to determine whether the background and site datasets are similar with regard to linear regression best fit. The slope of strongly correlated and significantly associated congener pairs is one. A deviation from one indicates the presence of outliers which may indicate point sources.

Activities:

Direct Comparisons

Determine the total number of congener pairs with slopes 0.75-1.25 in background and onsite datasets.

Statistical Comparisons

Determine if there is a statistical difference between background and site dataset slopes at a 95 percent confidence level (i.e. Wilcoxon-Rank Sum test)

Exhibit A-6-5
Phase 2
Step 4: Conduct Weight of Evidence Analysis

STEP 1
Compare Correlation Coefficients Identify and Compare Highly Correlated Congener Pairs

↓

STEP 2
Compare Y-intercepts
Evaluate Mass Ratios Between Correlated Congener Pairs

↓

STEP 3
Compare Slopes
Evaluate Slopes and Linear Regression Relationships For Correlated Congener Pairs

↓

STEP 4
Conduct Weight-of-Evidence Evaluation
Tabulate All Relevant Fingerprint Information-
Do Background and Site Congener Fingerprints Match?

STEP 4 – Conduct Weight of Evidence Analysis

Purpose:

To assemble all relevant fingerprint information for background and onsite datasets into a single table to allow for direct comparison. This analysis should focus on differences resulting from both onsite point and ubiquitous releases. Point releases can be identified through a spatial analysis of outliers that show one or a small subset of the dataset deviating from the fingerprint of both onsite and background dataset. In contrast, a ubiquitous release of dioxin congeners can be identified as an overall change in correlation coefficient ranks and individual mass ratios. A ubiquitous release will be superimposed on historical background which may be winnowed from the onsite dataset after background conditions are established in offsite samples. Ultimately all pertinent information will be used to answer the 2 question:

- Do the background and onsite congener fingerprints match?
- If they don't match how are they different?

A weight-of-evidence analysis based on these specific similarities and dissimilarities is used to determine whether fingerprints are a similar match. Exhibits A-6-1 through A-6-5 show the step-wise analysis, together with the decision criteria used in the weight-of-evidence analysis.

24. Gross differences between congener fingerprints that do not require detailed analysis of linear regression analysis (indicating large, ubiquitous enrichment)

25. Small areas with slightly different fingerprints suggesting enrichment (indicated by outlier patterns)

26. Subtle differences in mass ratios (indicating enrichment of a subset of congeners).

Gross differences between congener fingerprints are represented as a significant difference in the *number* of correlated congener pairs. The decision criteria for determining a significant difference is that there is a greater than or equal to (≥) 25% difference in correlated pairs (either an increase or decrease) in AK Steel and Background data sets.

One of the strengths of this statistical methodology is that small, discrete areas of enrichment (sources unrelated to AK Steel) can be readily identified on the basis of the outlier analysis. While outliers are identified as single samples having excess congener (≥ 2.5 standard deviations than the predicted concentration), an atypical sample is defined as having an outlier in ≥20% of the samples. Additionally, outliers must present a pattern in which the *same* congener was consistently identified as an outlier in numerous congener pairs in a particular sample location.

Ubiquitous enrichment of a subset of congeners is identified as a significant change in mass ratios (represented by the Y-intercept) of the subpopulation of congeners. A subtle enrichment is defined as a difference of ≥25% in the number of overlapping 95% confidence limits of the Y-intercept.

RESULTS

The results of the fingerprint analysis are presented in this section. The fingerprints are based on the most recent dioxin-like PCB, dioxin, and furan congener analysis. Fingerprints have been developed for all sediments and floodplain soils (here after referred to as sediments) and fish samples. For purposes of clarity, fingerprints for PCB congeners were developed separately from dioxin-furan fingerprints. The fingerprint for the contaminated areas of Dick's Creek and Monroe Ditch are represented by all samples collected downstream of sample location S17 The background conditions are represented by the background samples described previously, and are represented by samples collected upstream of sample location S17. The fingerprints of all samples collected upstream of sample location S17 are collectively referred to as the background fingerprints. It should be stressed that a release of PCBs from a single source is represented by numerous highly correlated pairs indicating that the PCBs in each sample are homogenous related in both temporal and spatial aspects. In contrast, anthropogenic background conditions are extremely heterogeneous because there are myriad sources of low levels of PCBs in the environment.

Exhibit A-7 presents the correlation between all PCB-congners in the contaminated downstream regions of Monroe Ditch and Dick's Creek. It also presents anomalies identified as potential third party releases. Note that the PCB mixture in the contaminated downstream area are strongly related and appear to be nearly homogeneous from a single source. Almost every PCB congener pair is highly correlated.

EXHIBIT A-7
CONTAMINATED SEDIMENTS: DIOXIN-LIKE PCB CORRELATION COEFFICIENTS AND OUTLIERS

PCB No.	77		81		105		114		118		123		126		156		167	
81	1.0																	
105	.97	S30	.96	S30														
114	.97	S30	.97	S30	1.0	S27												
118	.96	S30	.95	S30	1.0		.99	S24										
123	.97	S30	.97	S30	1.0		.99	S27	.99	S24								
126	.99	S30	.98	S30	.98	S30	.99	S30	.98	S30	.99	S30						
156	.92	S30	.91	S30	.98	S30	.98	S30	.99	S30	.98	S30	.95	S30				
167	.92	S30	.90	S30	.98	S30	.97	S30	.98	S30	.97	S30	.94	S30	1.0	D32 S06		
189	.93	S30	.91	S30	.96	S23	.97	S23	.98	S23	.96	S23	.96	S30	.98	S12 S30	.98	S30

Note: First column for each PCB pair represents the Correlation Coefficient. The second column represents the sample number(s) identified as outliers.

Exhibit A-8 presents an graphical example of a very strongly correlated PCB congener pair showing nearly all data fall on the linear regression line.

EXHIBIT A-8
EXAMPLE OF THE HIGHLY CORRELATED PCB CONGENERS IN CONTAMINATED SEDIMENTS
Ln(PCB 105) = 1.48 + 0.83 * Ln(PCB 77)
Correlation Coefficient = 0.99
R-squared = 99.21

Linear Regression Plot Showing Near Perfect Correlation Between:

PCB 105 AND PCB 77

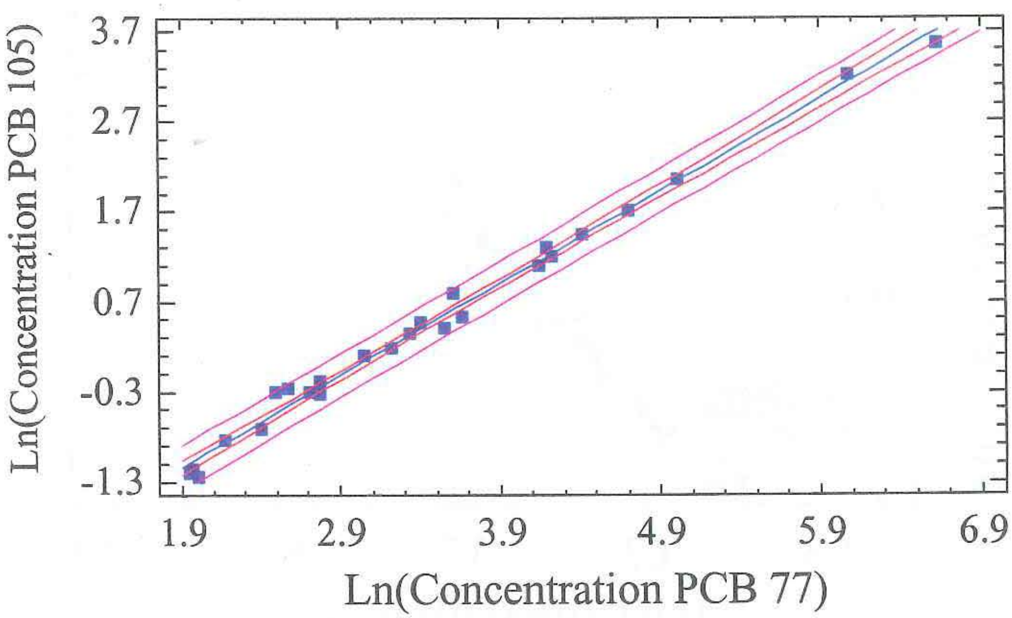


Exhibit A-9 shows outliers are readily identified with linear regression analysis. Sample S30 is clearly different from all other samples.

EXHIBIT A-9
Using Linear Regression To Identify Outliers-Potential Third Party Releases
LOG(105) = 1.48 + 0.83 * LOG(77)
CORRELATION COEFFICIENT = 0.95
R-SQUARED = 91 PERCENT

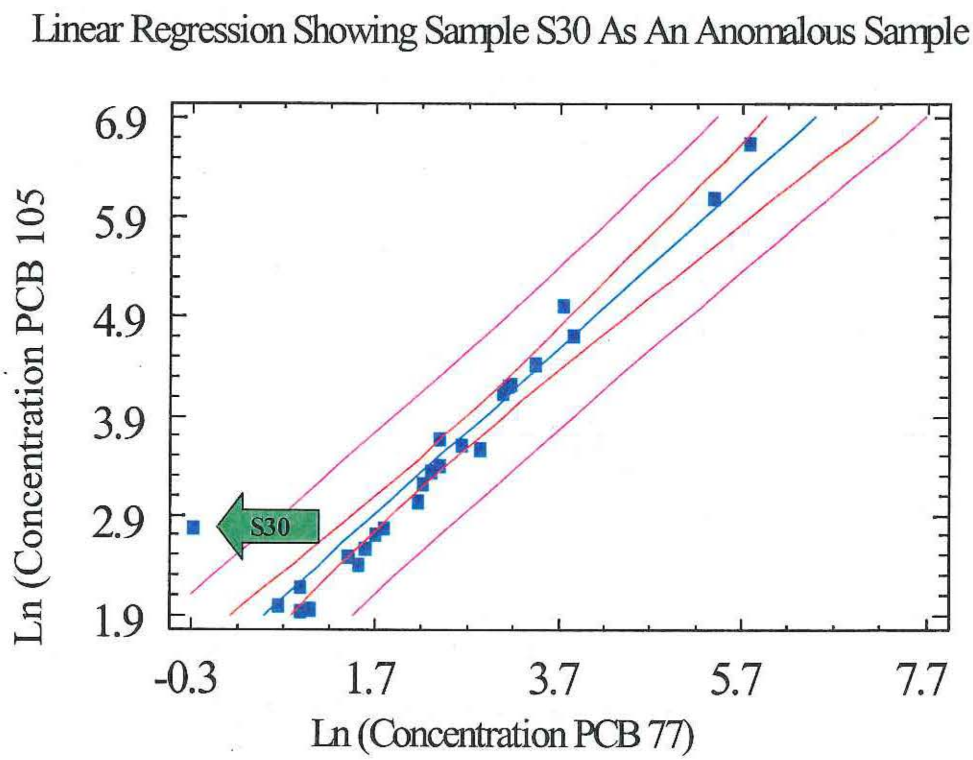


Exhibit A-10 shows a residual plot used to confirm samples are outliers. Sample s30 is clearly different from all other samples.

EXHIBIT A-10
Using Residual Plots To Identify Outliers-Potential Third Party Releases

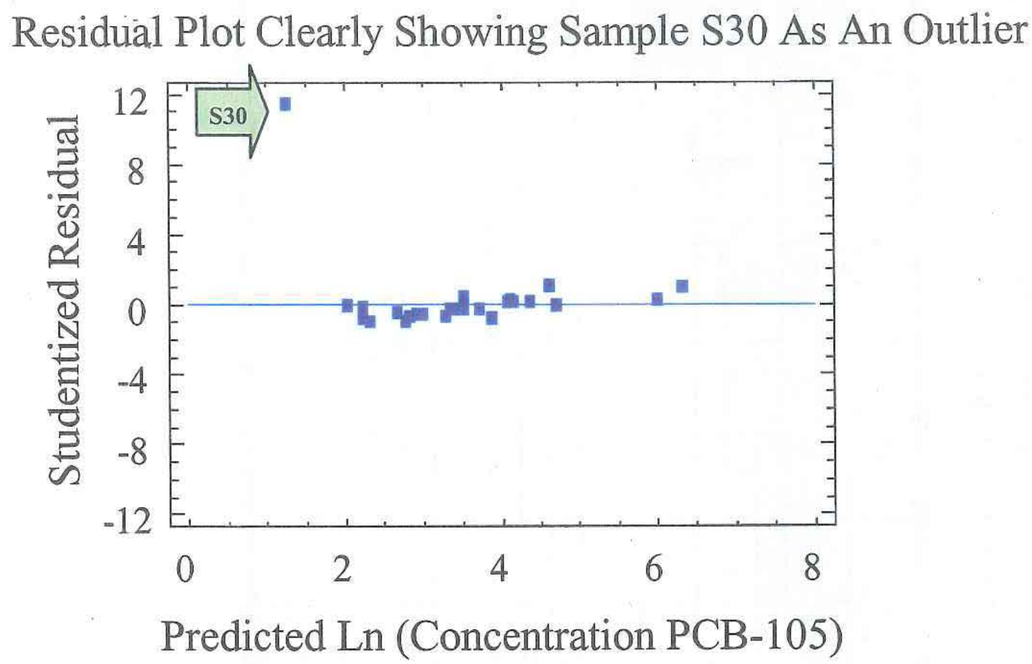


Exhibit A-11 presents the highly correlated dioxin and furan congeners together with samples identified as outliers.

EXHIBIT A-11
CONTAMINATED SEDIMENTS: DIOXIN AND FURAN CORRELATION COEFFICIENTS AND OUTLIERS

	2,3,7,8-TCDF		1,2,3,7,8-PeCDF		2,3,4,7,8-PeCDF		1,2,3,4,7,8-HxCDF		2,3,4,6,7,8-HxCDF		1,2,3,7,8,9-HxCDF		1,2,3,4,6,7,8-HpCDF		OCDF		2,3,7,8-TCDD	
1,2,3,7,8-PeCDF	.95																	
2,3,4,7,8-PeCDF	.98	S30	.94	S06														
1,2,3,4,7,8-HxCDF	.96		.96		.97	S23												
2,3,4,6,7,8-HxCDF	.90		.96	S30	.86	S30	.91	S30										
1,2,3,7,8,9-HxCDF	NA		NA		NA		NA		NA									
1,2,3,4,6,7,8-HpCDF	.70	S23	.70		NA		NA		.85		NA							
OCDF	NA		NA		NA		NA		.77	S13	NA		.96	S13 S43				
2,3,7,8-TCDD	NA		NA		NA		NA		NA		NA		NA		NA			
1,2,3,7,8-PeCDD	NA		NA		NA		NA		NA		NA		.70		NA		.81	S30
1,2,3,7,8,9-HxCDD	NA		NA		NA		NA		NA		NA		.82		.76	S43	.85	
1,2,3,4,6,7,8-HpCDD	NA		NA		NA		NA		.74	S12	NA		.92		.90		.74	S43
OCDD	NA		NA	S12	NA		NA		.73	S12	NA		.89		.89		NA	
1,2,3,6,7,8-HxCDF	.82		.88	S25	.81		.87		.90		NA		.83	S30	.81		NA	
1,2,3,4,7,8,9-HpCDF	.87		.92	S30	.83	S30	.90	S30	.97	S14	NA		.84		.77		NA	
1,2,3,4,7,8-HxCDD	NA		NA		NA		NA		.71	S12	NA		.88		.79	S43	.74	
1,2,3,6,7,8-HxCDD	NA		NA		NA		NA		.78	S12	NA		.90	S25	.85		.76	S43

EXHIBIT A-11 Continued

	1,2,3,7,8-PeCDD		1,2,3,7,8,9-HxCDD		1,2,3,4,6,7,8-HpCDD		OCDD		1,2,3,6,7,8-HxCDF		1,2,3,4,7,8,9-HpCDF		1,2,3,4,7,8-HxCDD		1,2,3,6,7,8-HxCDD	
1,2,3,7,8-PeCDF																
2,3,4,7,8-PeCDF																
1,2,3,4,7,8-HxCDF																
2,3,4,6,7,8-HxCDF																
1,2,3,7,8,9-HxCDF																
1,2,3,4,6,7,8-HpCDF																
OCDF																
2,3,7,8-TCDD																
1,2,3,7,8-PeCDD																
1,2,3,7,8,9-HxCDD	.93	S03 S30														
1,2,3,4,6,7,8-HpCDD	.86	S03 S43	.96	S43												
OCDD	.85	S43	.93	S43	.99	S14										
1,2,3,6,7,8-HxCDF	NA		NA		.73	S29	.74	S29								
1,2,3,4,7,8,9-HpCDF	NA		NA		.71	S12	.74	S12	.88							
1,2,3,4,7,8-HxCDD	.84	S03	.94	S43	.97		.93	S43	NA		NA					
1,2,3,6,7,8-HxCDD	.86	S03	.95	S43	.99	S12	.96		.73	S29	.74	S12	.98	S01		

Note: Top Correlation Coefficient represents the original data set. The bottom Correlation Coefficient represents the trimmed data set. The column to the right indicates the sample number(s) identified as outliers.

BACKGROUND SEDIMENT FINGERPRINTS

Exhibit A-12 presents the highly correlated PCB congener pairs in background sediments. This exhibit clearly shows that in contrast to the contaminated areas where the PCB mixtures were highly structured (homogeneous) with all congener pairs highly correlated because they originated from a single source (AK Steel), the low level of PCBs in the background area is highly unstructured (heterogeneous) with very few highly correlated congener pairs .

EXHIBIT A-12
BACKGROUND SEDIMENTS: DIOXIN-LIKE PCB CORRELATION COEFFICIENTS AND OUTLIERS

	PCB 77		PCB 81		PCB 105		PCB 114		PCB 118		PCB 123		PCB 126		PCB 156		PCB 167	
PCB 81																		
PCB 105	.81																	
PCB 114																		
PCB 118	.74				.98													
PCB 123																		
PCB 126																		
PCB 156																		
PCB 167																		
PCB 189																		

Note: First Column for Each Pcb Pair Represents the Correlation Coefficient. The Second Column Represents the Sample Number(s) Identified as Outliers. Blank Cells Represent No Correlation.

EXHIBIT A-13
SEDIMENTS: BACKGROUND DIOXIN AND FURAN CORRELATION COEFFICIENTS: UNTRIMMED AND TRIMMED DATASETS & OUTLIER SAMPLE NUMBER

	2,3,7,8-TCDF	1,2,3,7,8-PeCDF	2,3,4,7,8-PeCDF	1,2,3,4,7,8-HxCDF	2,3,4,6,7,8-HxCDF	1,2,3,7,8,9-HxCDF	1,2,3,4,6,7,8-HpCDF	OCDF	2,3,7,8-TCDD	1,2,3,7,8-PeCDD	1,2,3,7,8,9-HxCDD	1,2,3,4,6,7,8-HpCDD	OCDD	1,2,3,6,7,8-HxCDF	1,2,3,4,7,8,9-HpCDF	1,2,3,4,7,8-HxCDD	1,2,3,6,7,8-HxCDD
1,2,3,7,8-PeCDF																	
2,3,4,7,8-PeCDF																	
1,2,3,4,7,8-HxCDF																	
2,3,4,6,7,8-HxCDF																	
1,2,3,7,8,9-HxCDF																	
1,2,3,4,6,7,8-HpCDF																	
OCDF							.98										
2,3,7,8-TCDD																	
1,2,3,7,8-PeCDD																	
1,2,3,7,8,9-HxCDD																	
1,2,3,4,6,7,8-HpCDD							.82	.84									
OCDD							.76	.80				.99					
1,2,3,6,7,8-HxCDF							.95	.97 S 16				.94	.92				
1,2,3,4,7,8,9-HpCDF																	
1,2,3,4,7,8-HxCDD																	
1,2,3,6,7,8-HxCDD																	

Note: Top Correlation Coefficient represents the original data set. The bottom Correlation Coefficient represents the trimmed data set. The column to the right indicates the sample number(s) identified as outliers.

Exhibit A-14 Identifies PCB and dioxin and furan outliers within both contaminated and background areas. As shown, only sample s30 is identified as an outlier as it was identified in more than 76 percent of samples.

EXHIBIT A-14

CONTAMINATED AND BACKGROUND SEDIMENTS WITH OUTLIER SAMPLES

SAMPLE NUMBER	TOTAL NUMBER OF SAMPLES CONTAINING OUTLIERS	PERCENTAGE OF SAMPLES WITH OUTLIER ?	DO OUTLIERS DISPLAY PATTERN?	CONSIDER SAMPLE AS POTENTIALLY ANOMALY?
DIOXIN-LIKE PCBs				
CONTAMINATED				
S30	33	78.6%	YES	YES
S23	4	9.5%	NO	NO
S24	2	4.8%	NO	NO
S27	2	4.8%	NO	NO
D32	1	2.4%	NO	NO
S06	1	2.4%	NO	NO
S12	1	2.4%	NO	NO
BACKGROUND SEDIMENTS				
OUTLIERS	0	0		
DIOXIN-FURANS				
CONTAMINATED				
S43	12	26.7%	YES	YES
S30	10	22.2%	YES	YES
S12	9	20.0%	YES	YES
S29	3	6.7%	NO	NO
S03	4	8.9%	NO	NO
S23	2	4.4%	NO	NO
S13	2	4.4%	NO	NO
S14	2	4.4%	NO	NO
S25	2	4.4%	NO	NO
S01	1	2.2%	NO	NO
S06	1	2.2%	NO	NO
BACKGROUND SEDIMENTS				
NONE				

Note: Some correlated pairs had more than one outlier.

Exhibits A-15 and A-16 present the final comparison of contaminated and background fingerprints.

EXHIBIT A-15
COMPARISON OF CONTAMINATED AND BACKGROUND SEDIMENT FINGERPRINTS PCB CONGENERS

	Number of Correlated Congener Pairs	Number of Identical Matching Congener Pair Matches	Number of Pairs With R $\geq$ 0.9	Number of Pairs With 0.9 > R $\geq$ 0.8	Number of Pairs With 0.8 > R $\geq$ 0.7	Number of Missing Congener Pair Marches
Contaminated sediments	45 (45)	3	45	0	0	0
Background sediments	3 (45)		1	1	1	42

EXHIBIT A-16
COMPARISON OF CONTAMINATED AND BACKGROUND SEDIMENT FINGERPRINTS DIOXIN-FURAN CONGENERS

	Number of Correlated Congener Pairs	Number of Identical Matching Congener Pair Matches	Number of Pairs With R $\geq$ 0.9	Number of Pairs With > R $\geq$ 0.8	Number of Pairs With 0.8 > R $\geq$ 0.7	Number of Missing Congener Pair Marches
Contaminated sediments	71(136)	10	28	23	20	50
Background	10 (136)		6	3	1	111

Exhibits A-17 through A-49 present histograms for all 209 PCB congeners.

EXHIBIT A-17

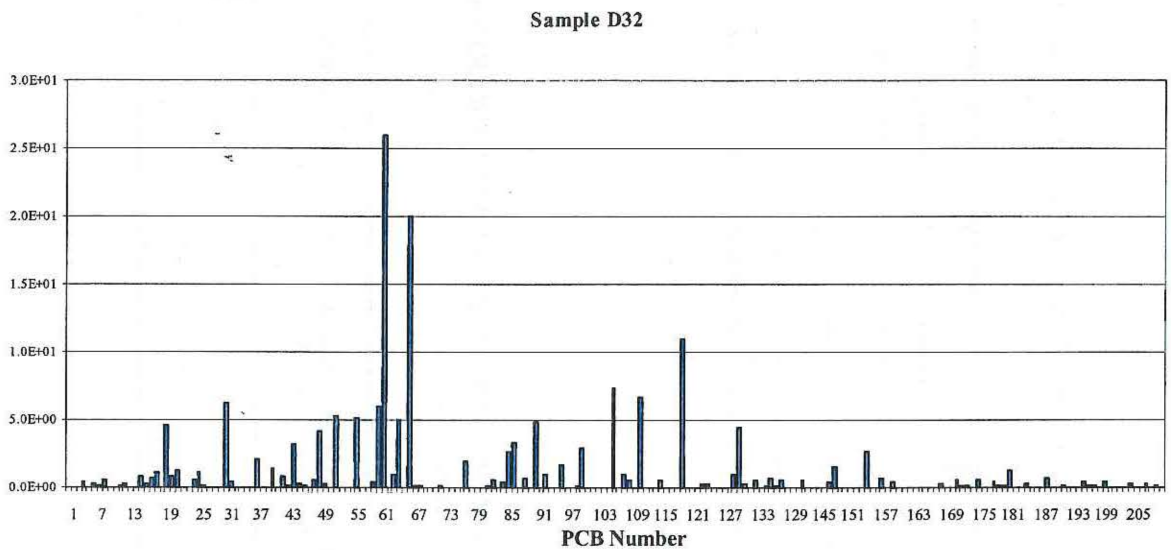


EXHIBIT A-18

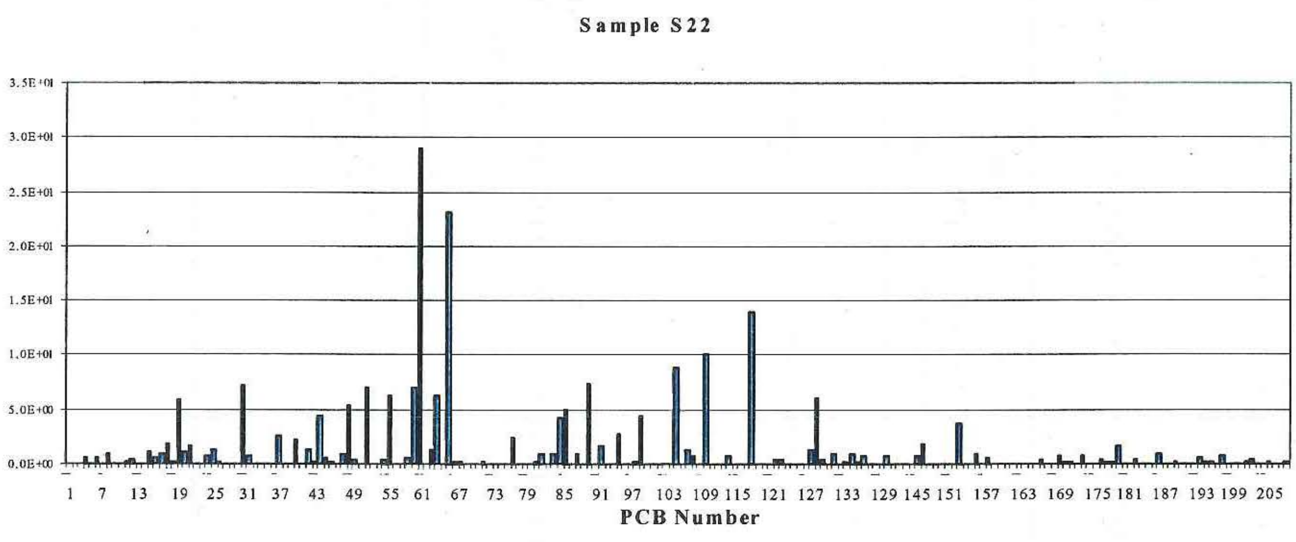


EXHIBIT A-19

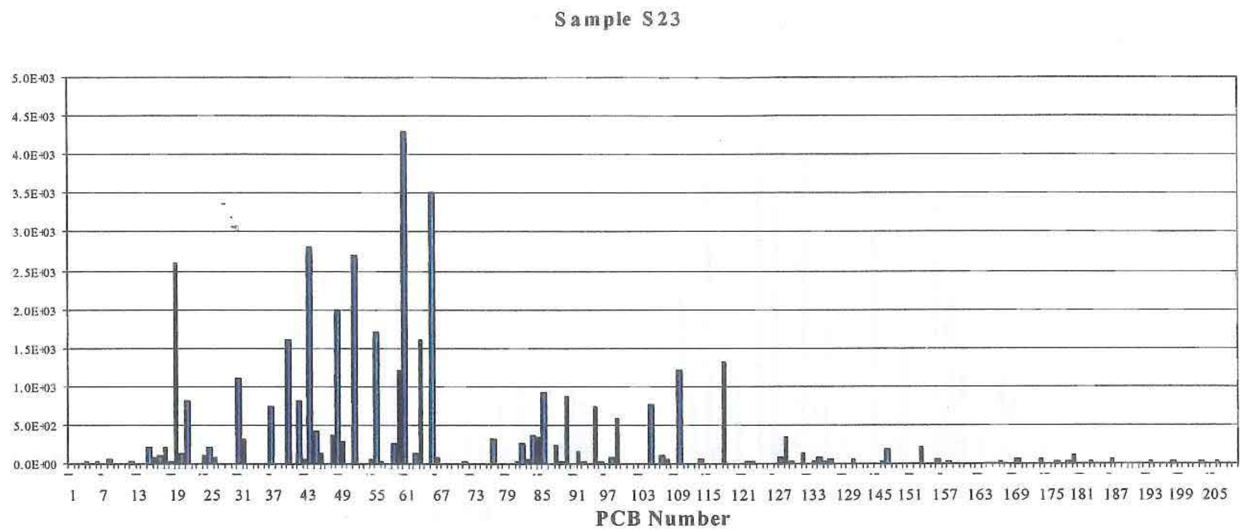


EXHIBIT A-20

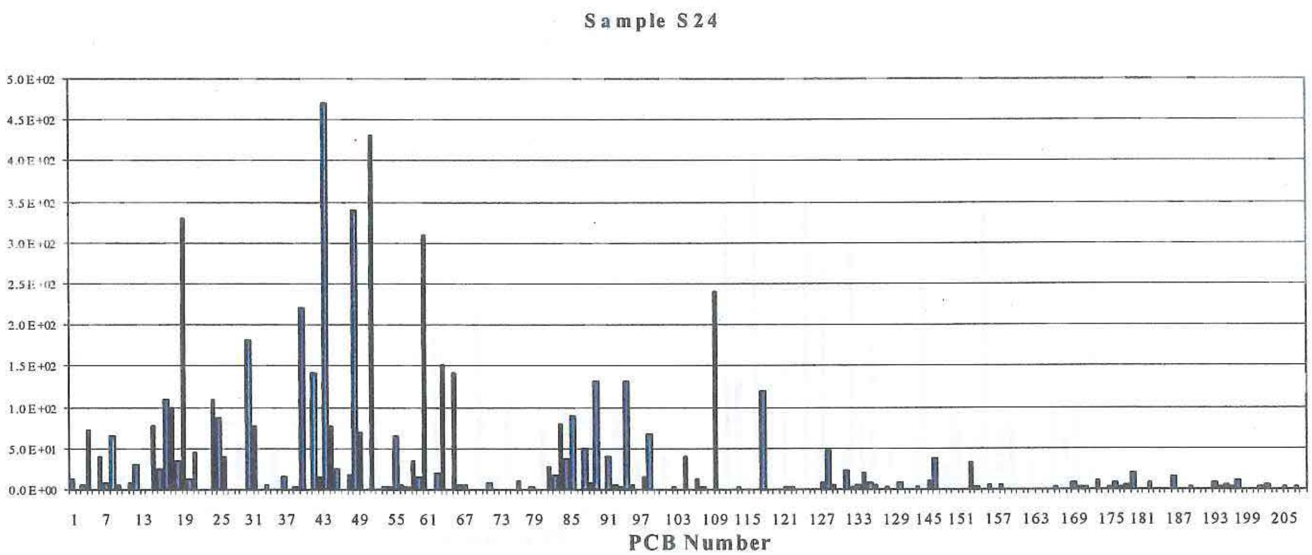


EXHIBIT A-21

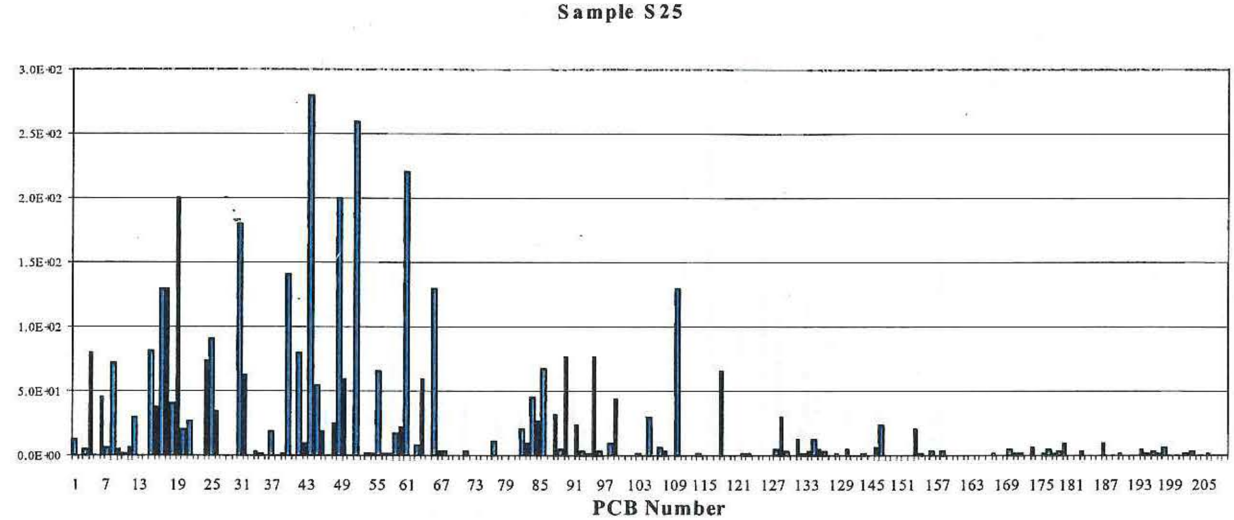


EXHIBIT A-22

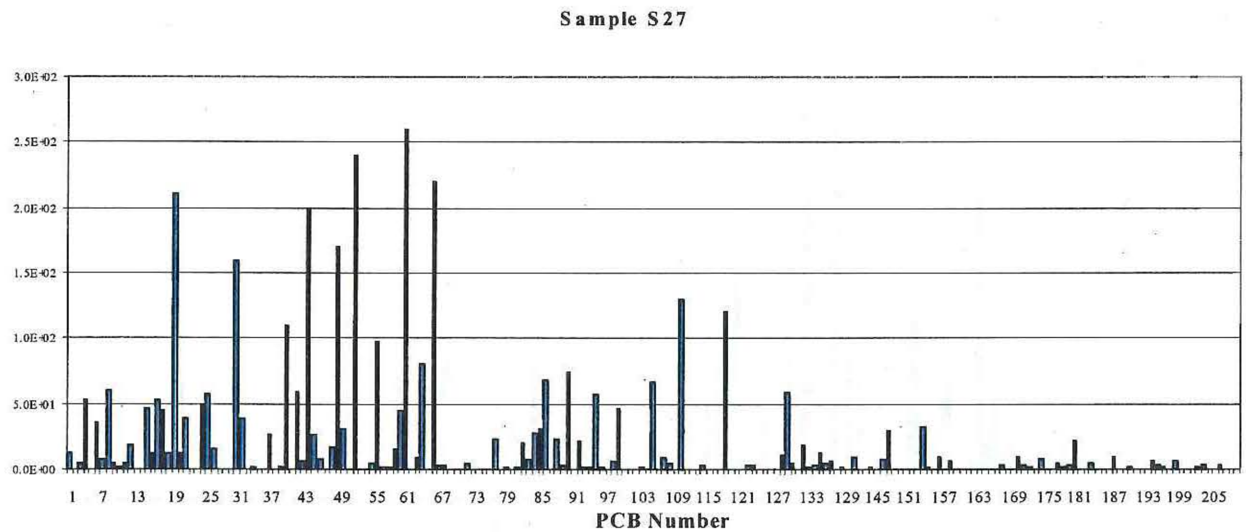


EXHIBIT A-23

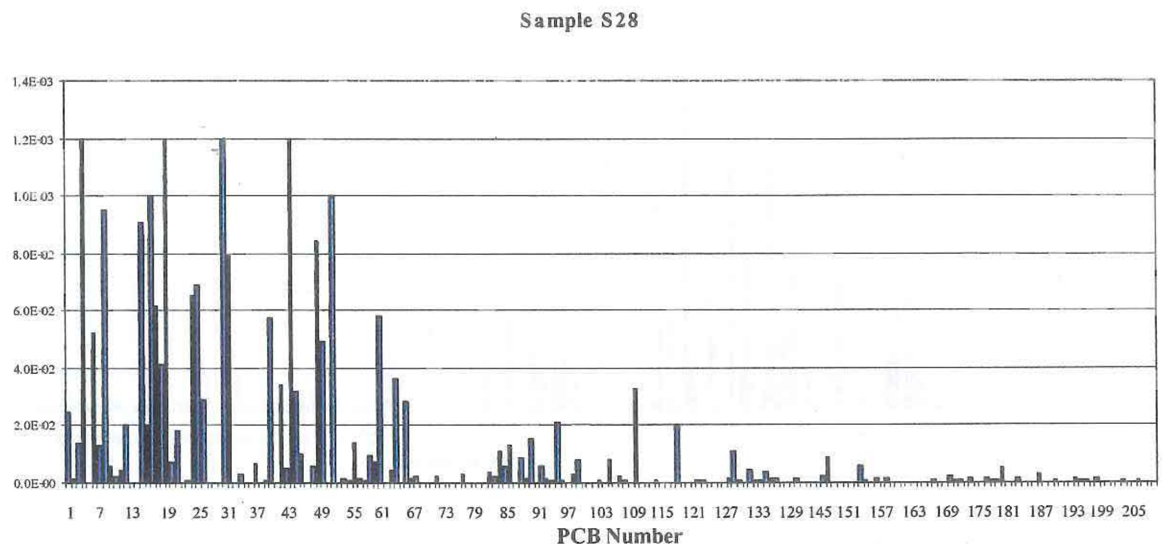


EXHIBIT A-24

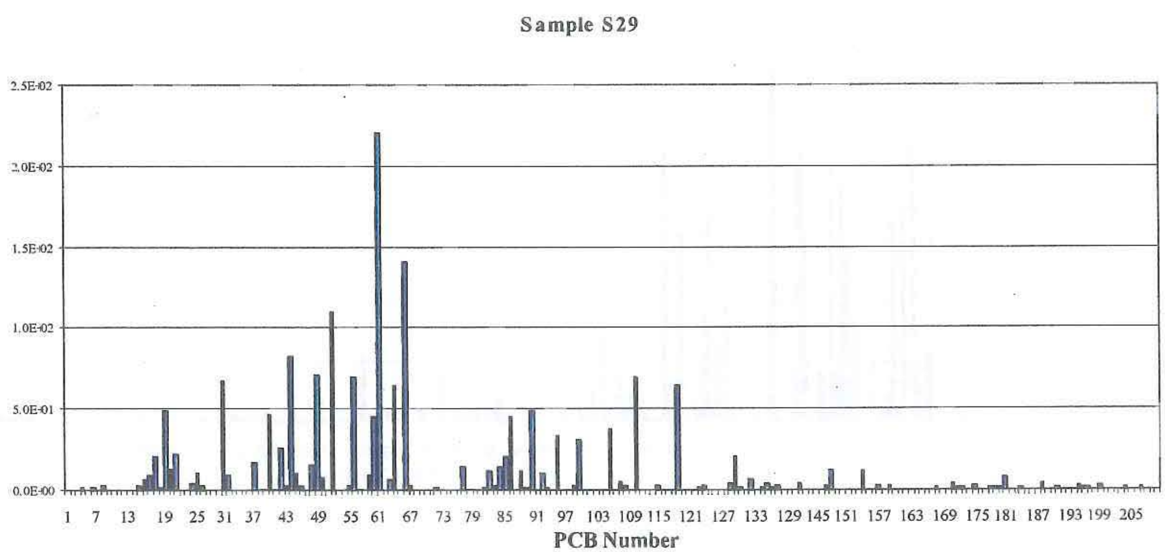


EXHIBIT A-25

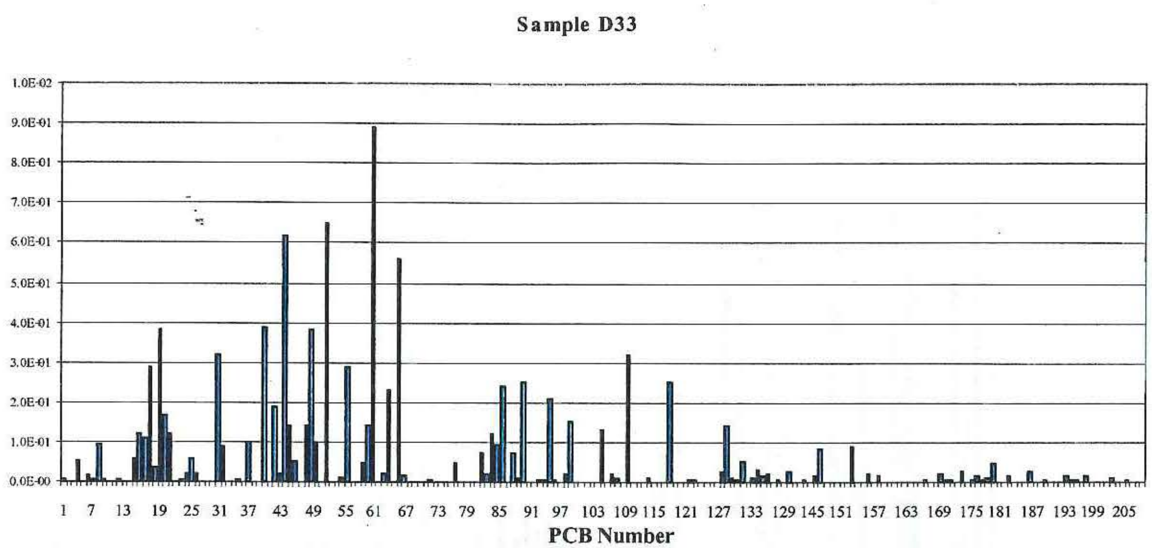


EXHIBIT A-26

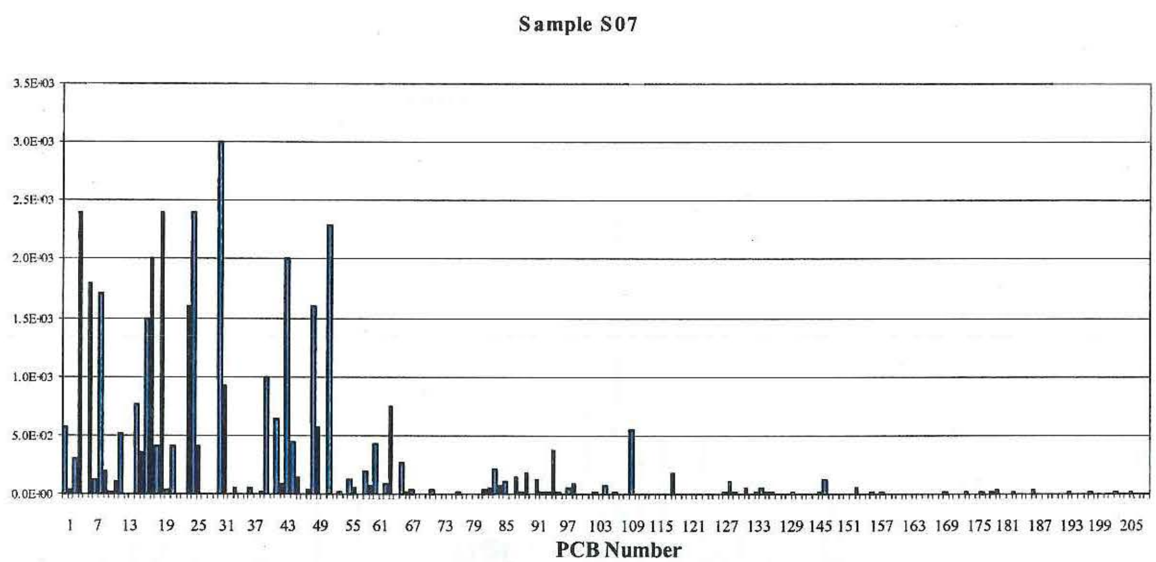


EXHIBIT A-27

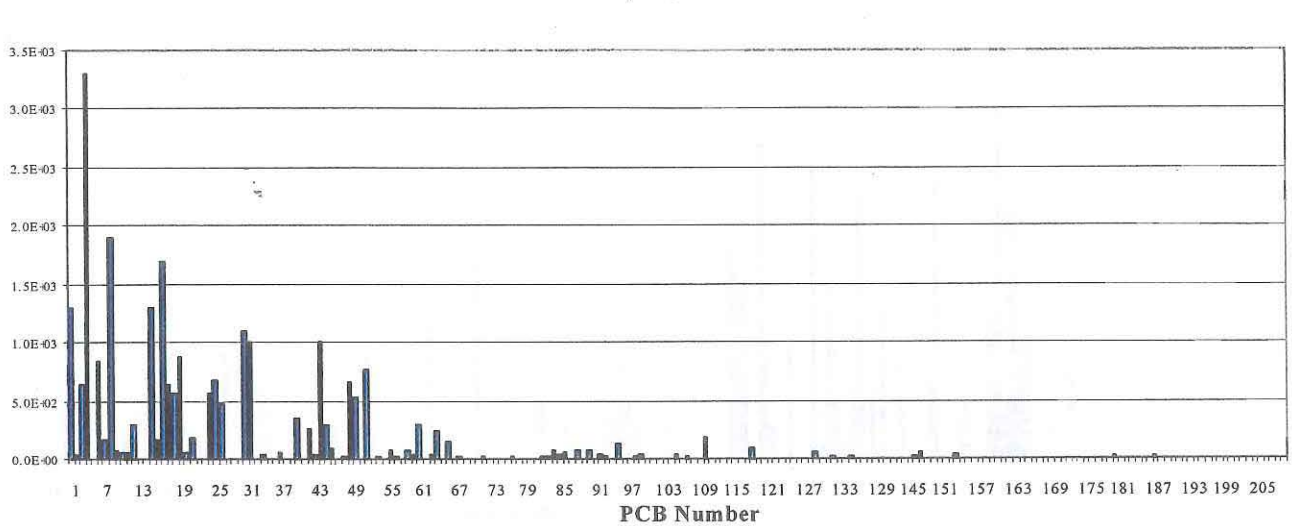


EXHIBIT A-28

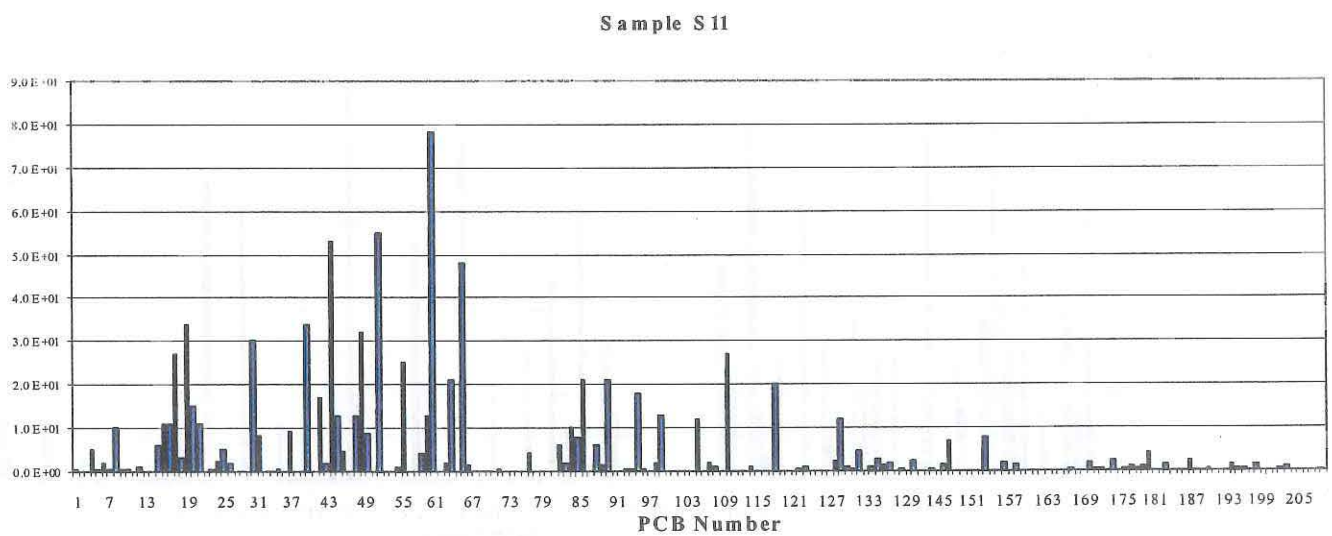


EXHIBIT A-29

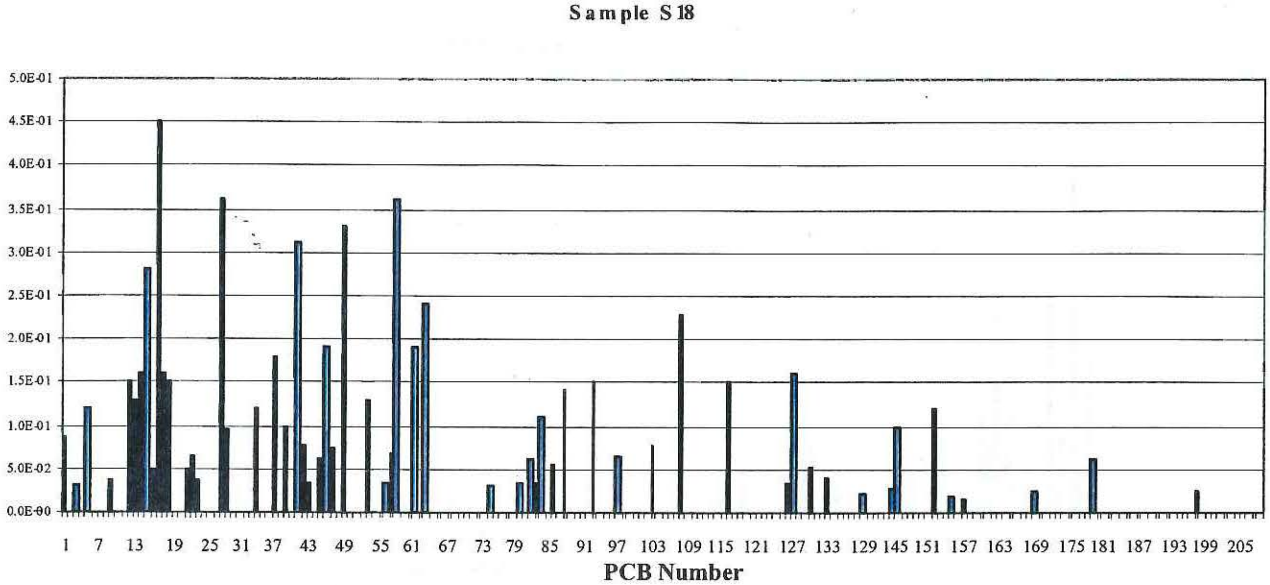


EXHIBIT A-30

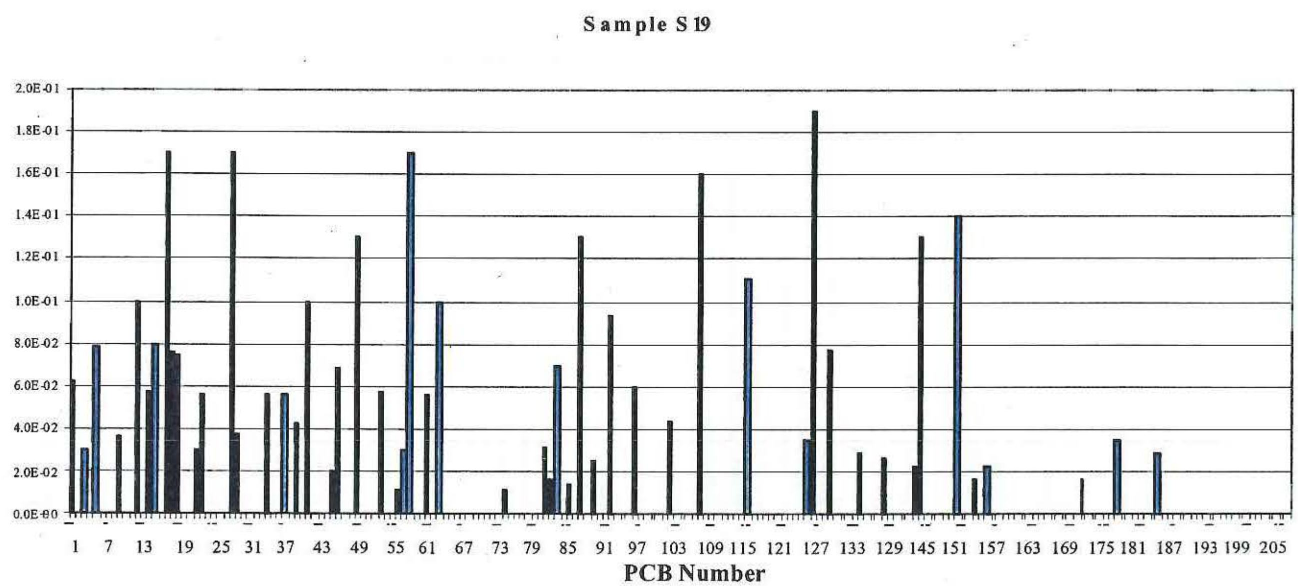
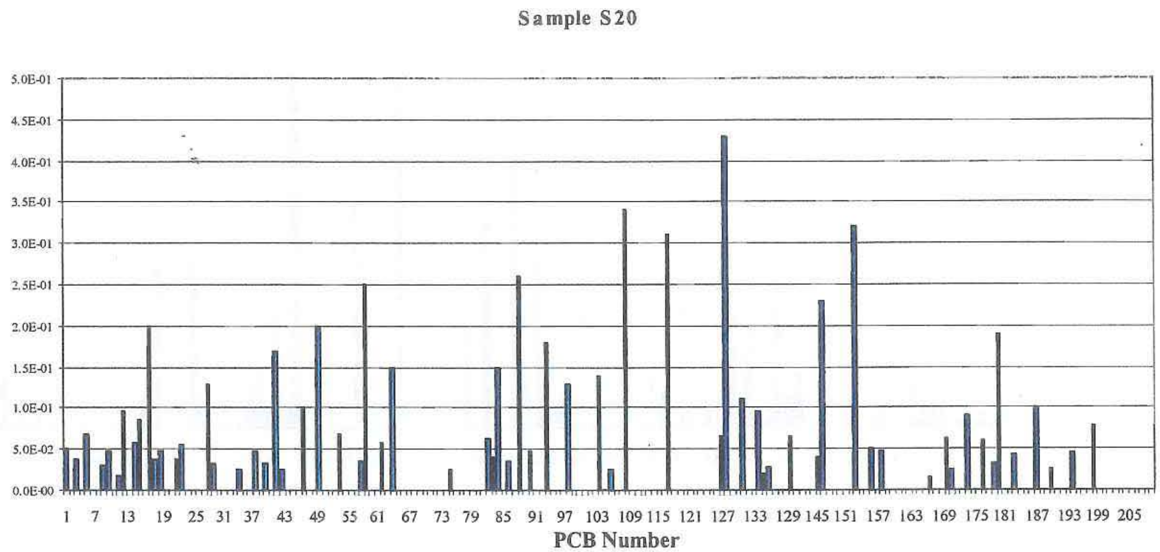


EXHIBIT A-31



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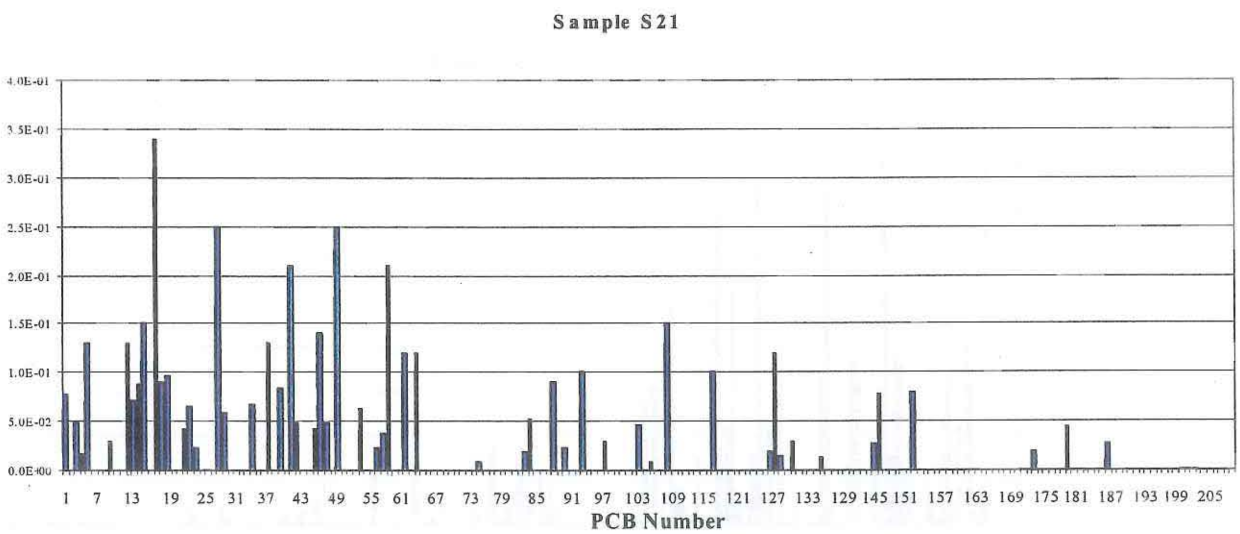


EXHIBIT A-33

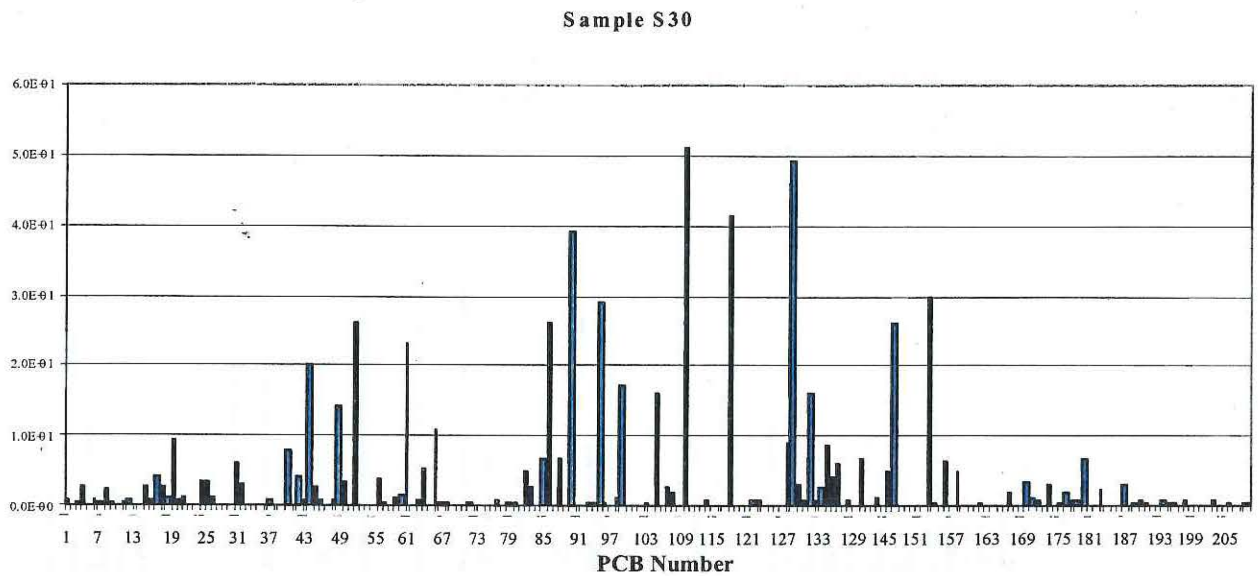


EXHIBIT A-34

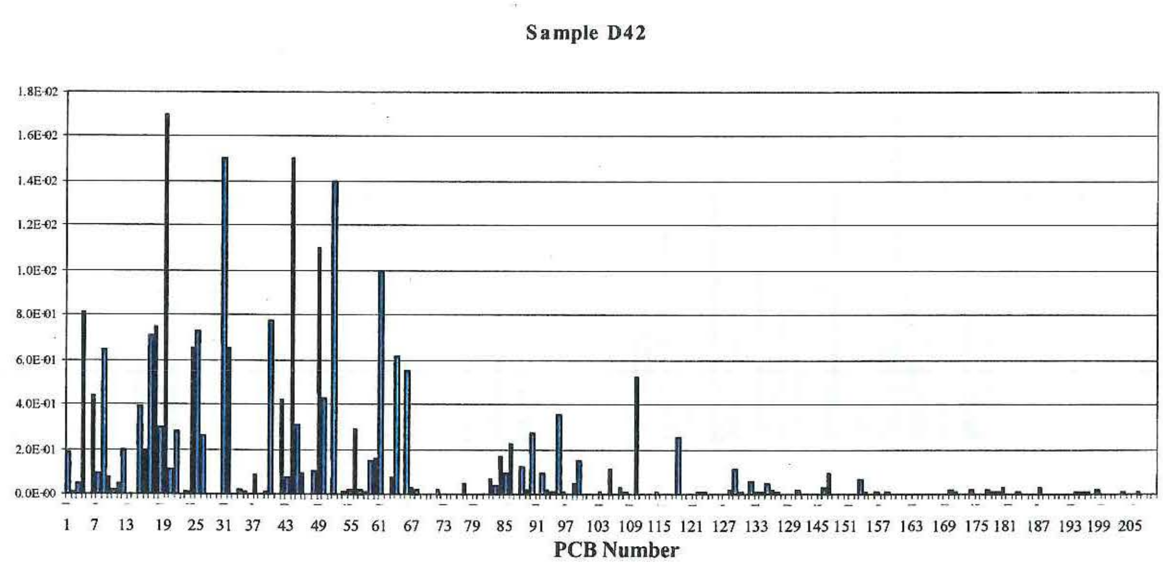
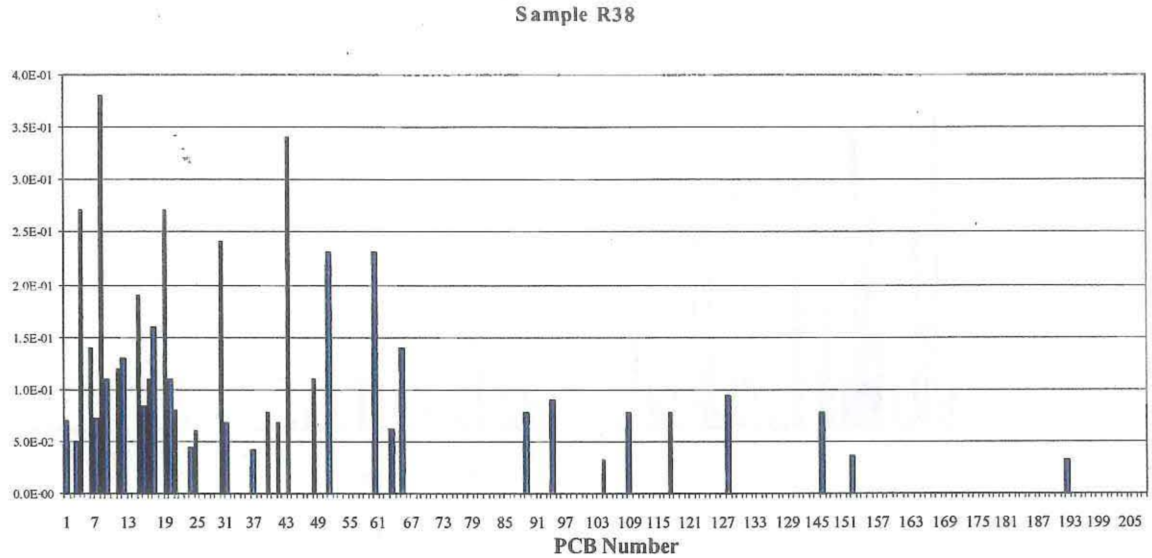


EXHIBIT A-35



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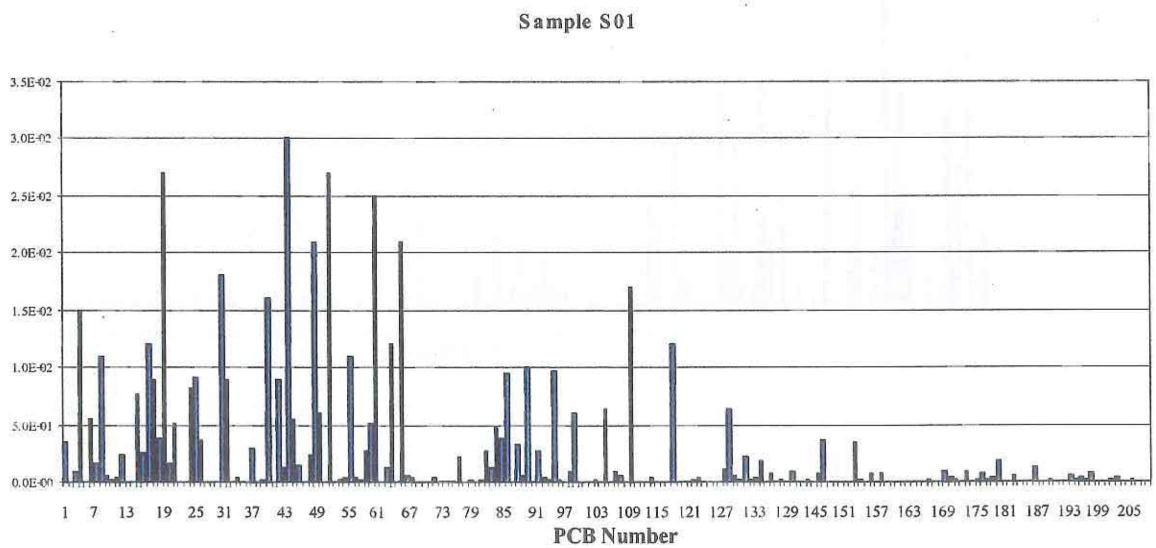

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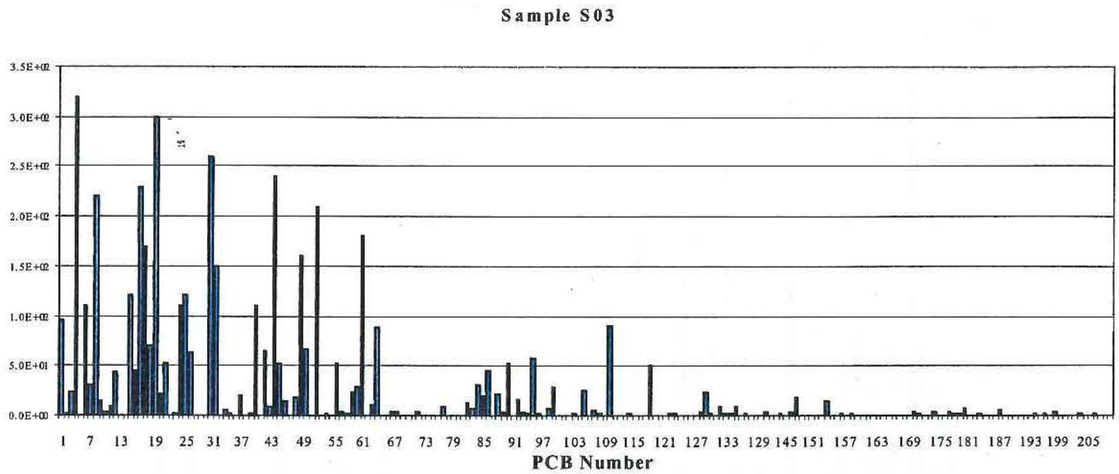
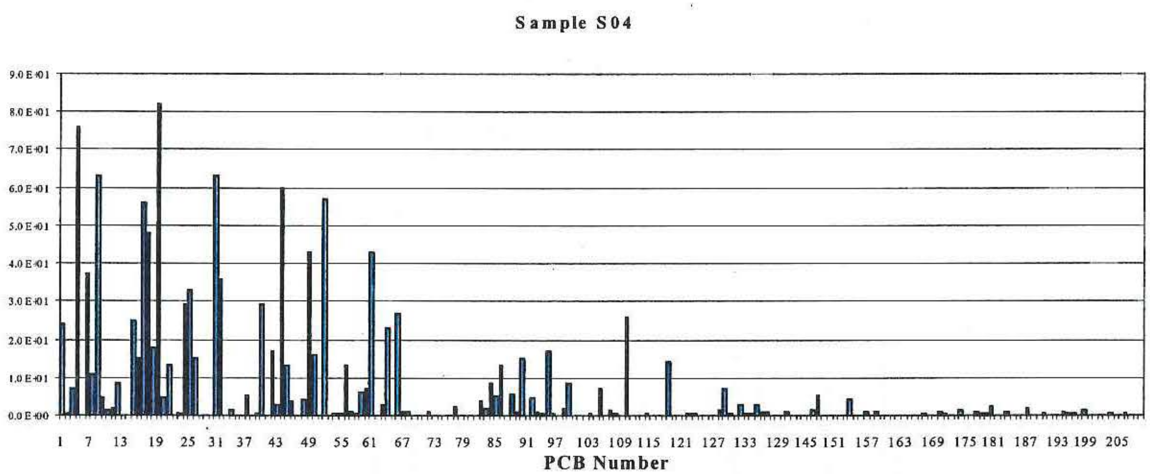


EXHIBIT A-38



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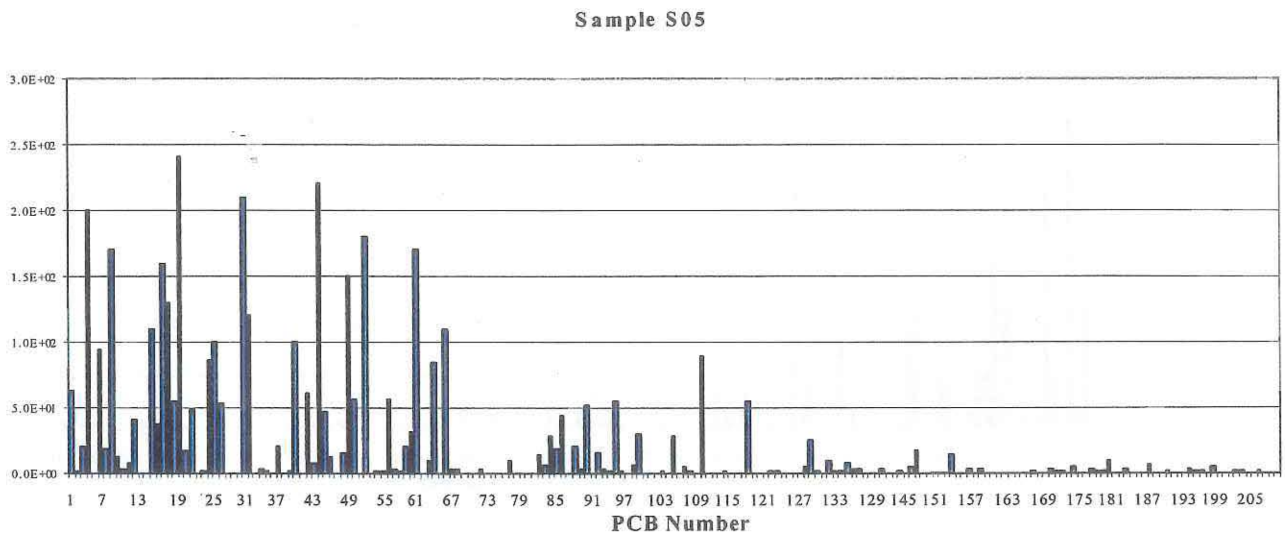


EXHIBIT A-40

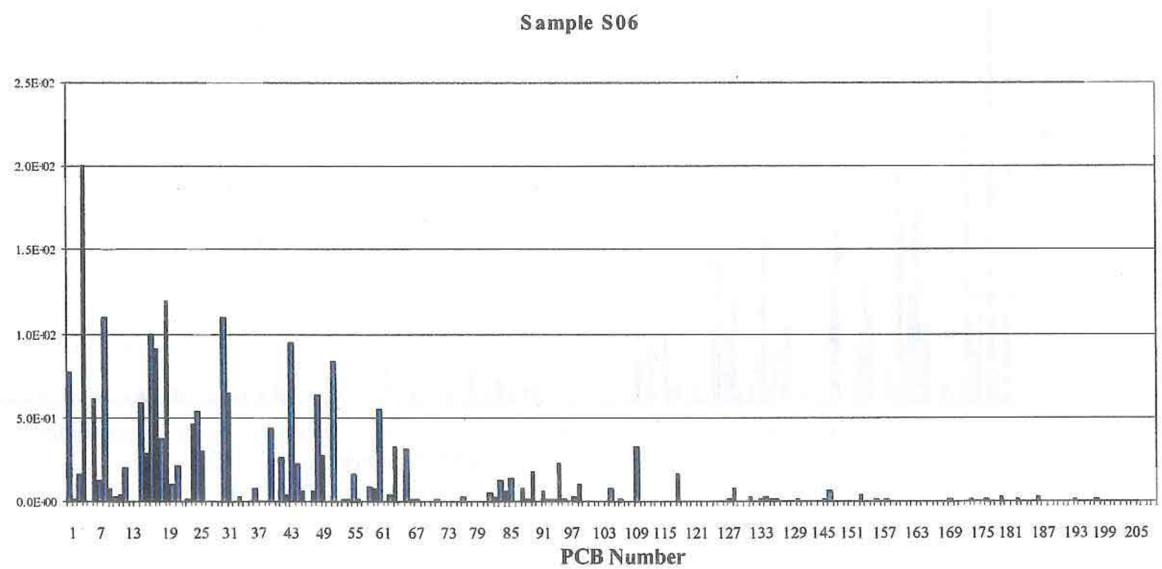
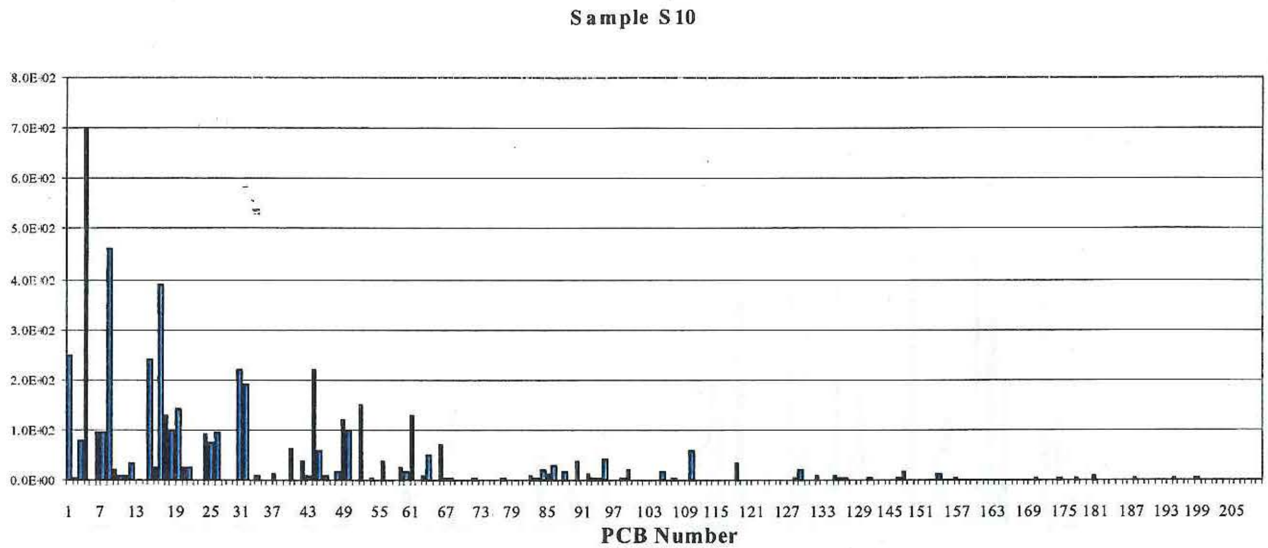


EXHIBIT A-41



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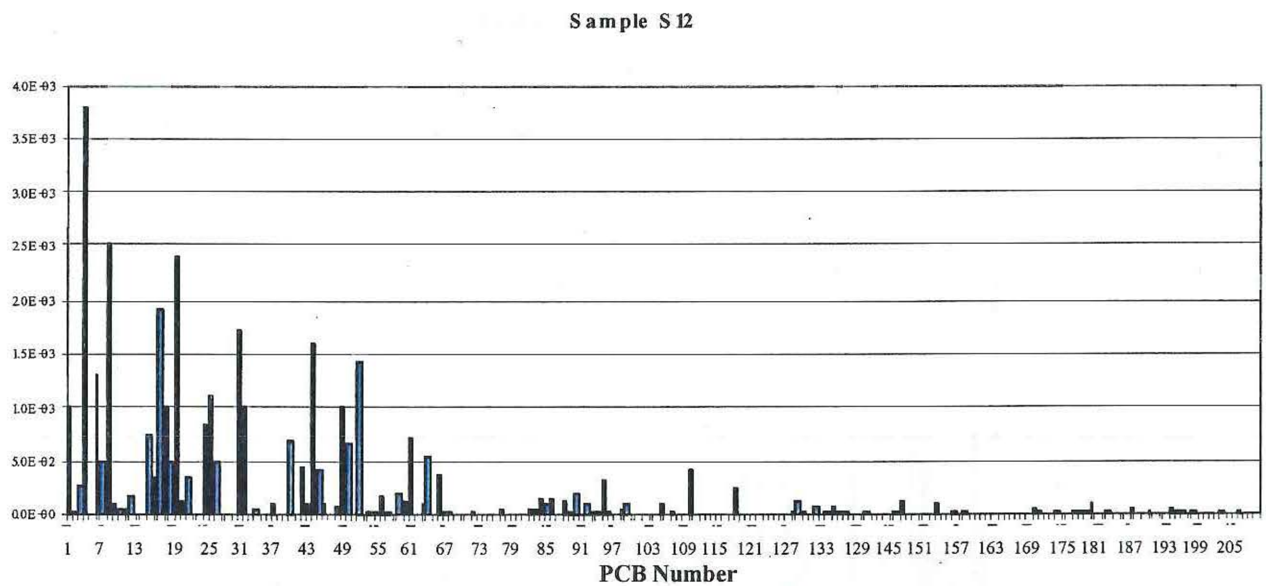


EXHIBIT A-43

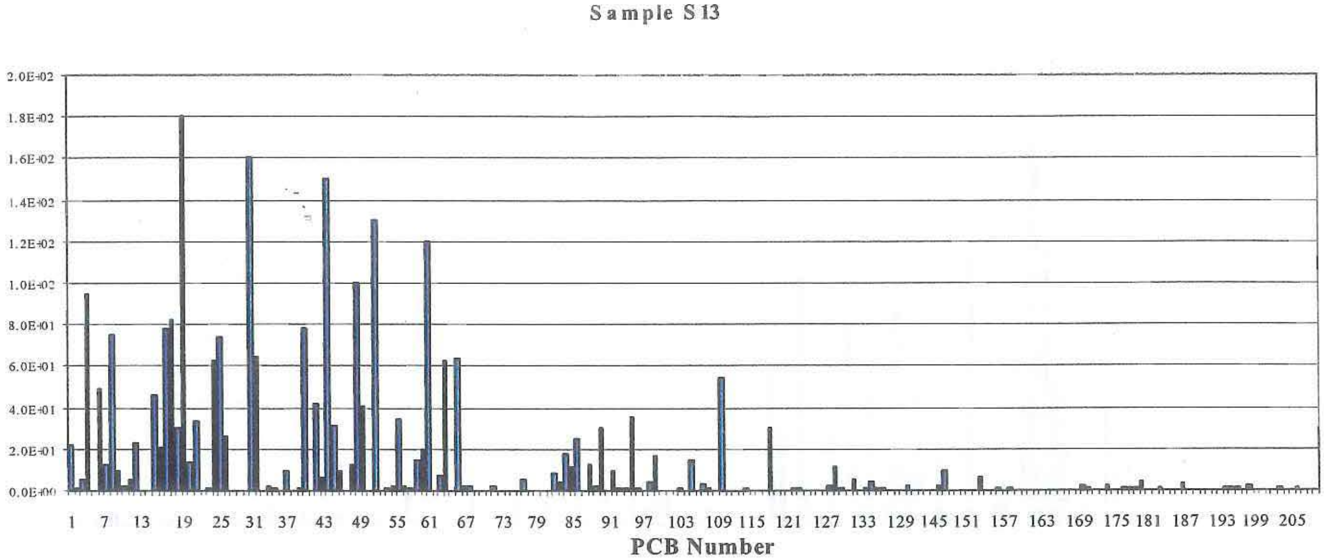


EXHIBIT A-44

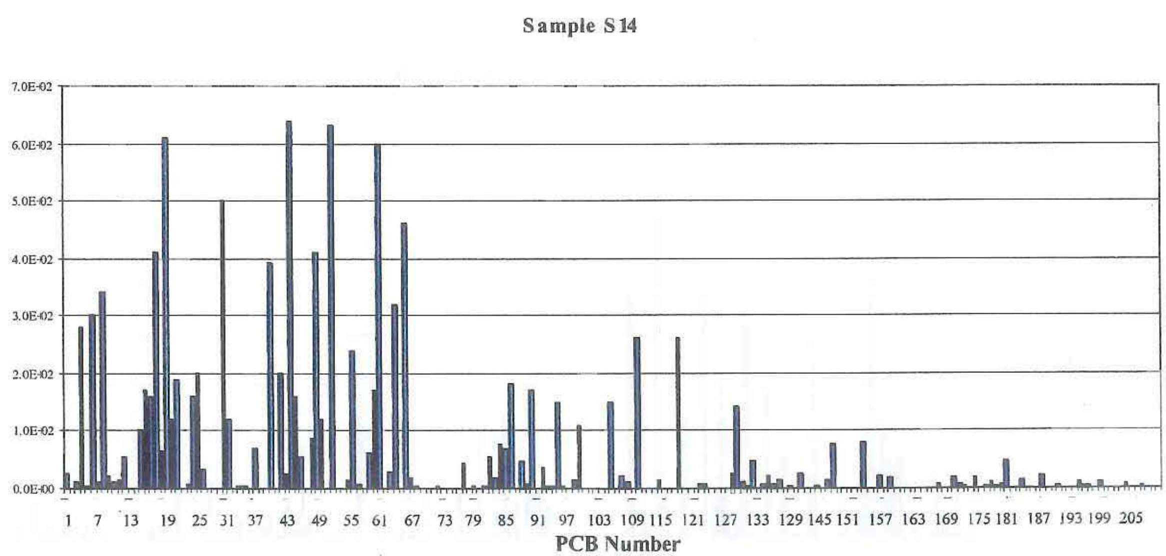


EXHIBIT A-45

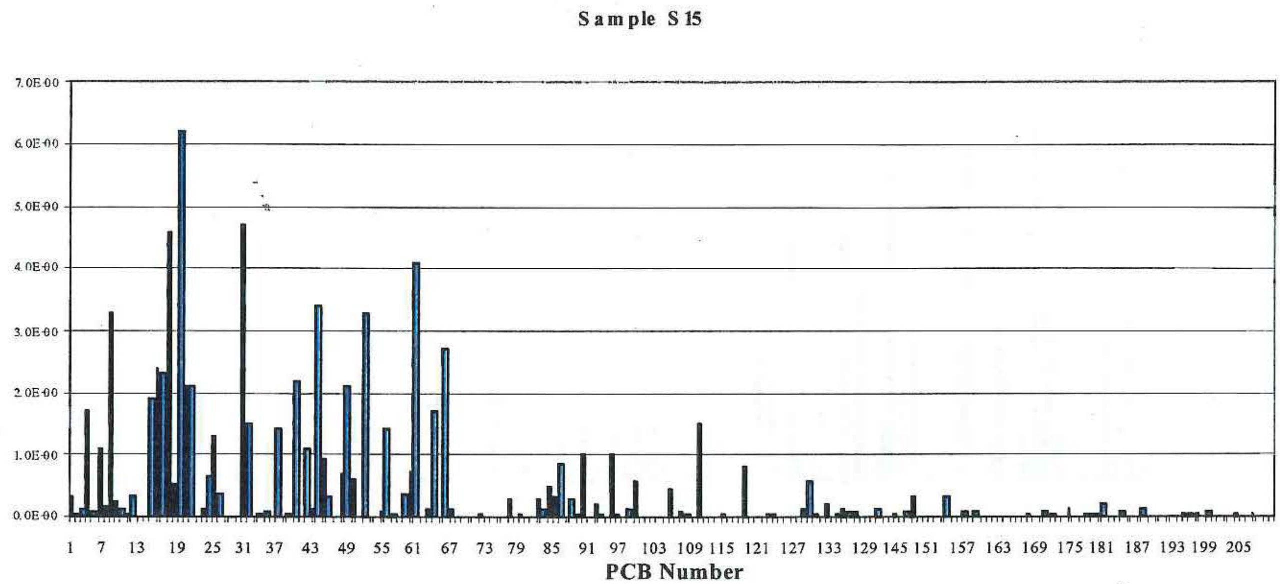


EXHIBIT A-46

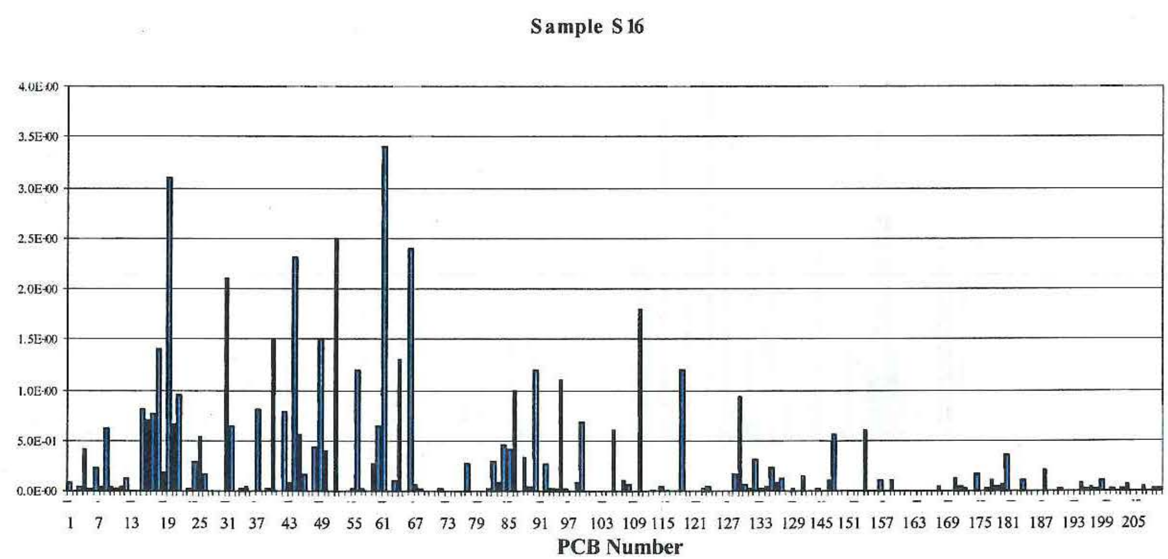


EXHIBIT A-47

Sample S17

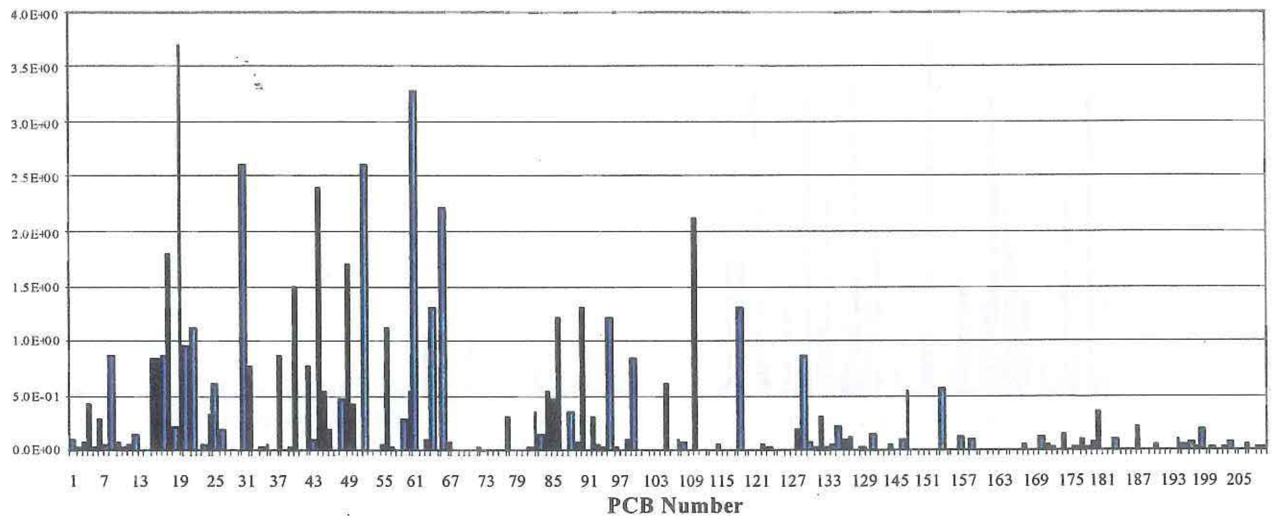


EXHIBIT A-48

Sample S31

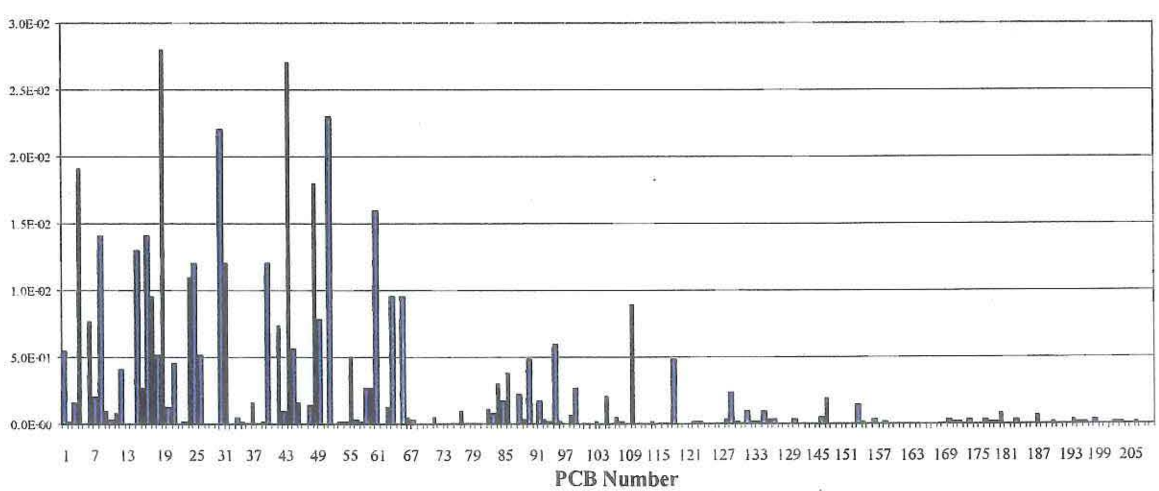
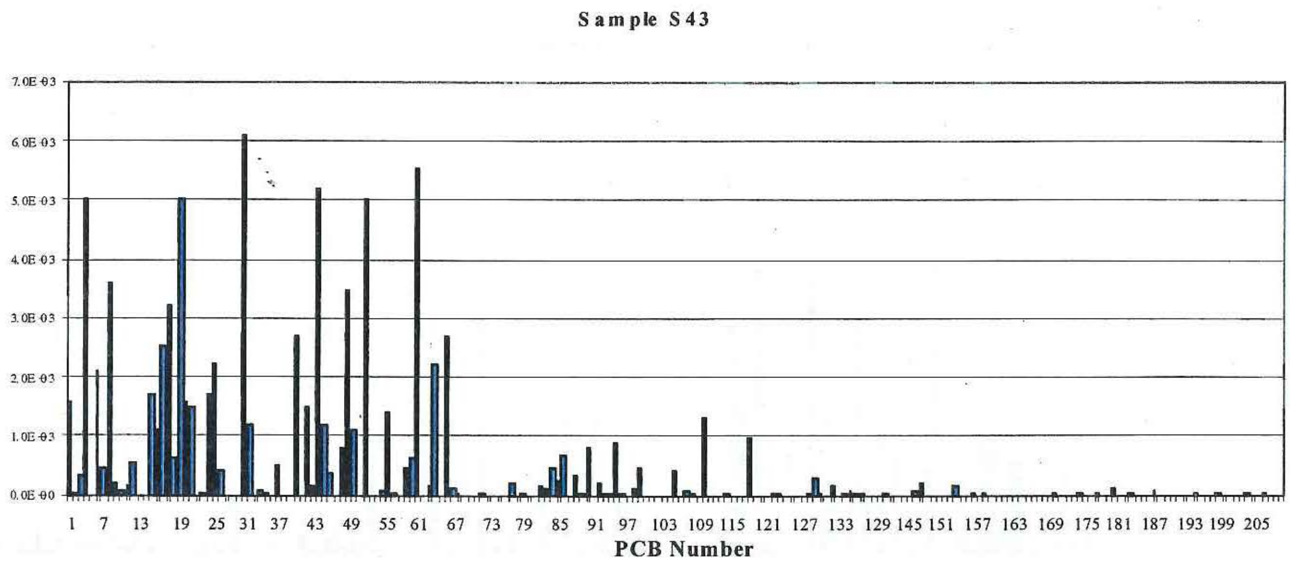


EXHIBIT A-49


Sample S43
7.0E-03
6.0E-03
5.0E-03
4.0E-03
3.0E-03
2.0E-03
1.0E-03
0.0E+00
1 7 13 19 25 31 37 43 49 55 61 67 73 79 85 91 97 103 109 115 121 127 133 129 145 151 157 163 169 175 181 187 193 199 205
PCB Number

Exhibits A-50 through A-82 present histograms for the 12 dioxin-like PCB congeners.

EXHIBIT A-50

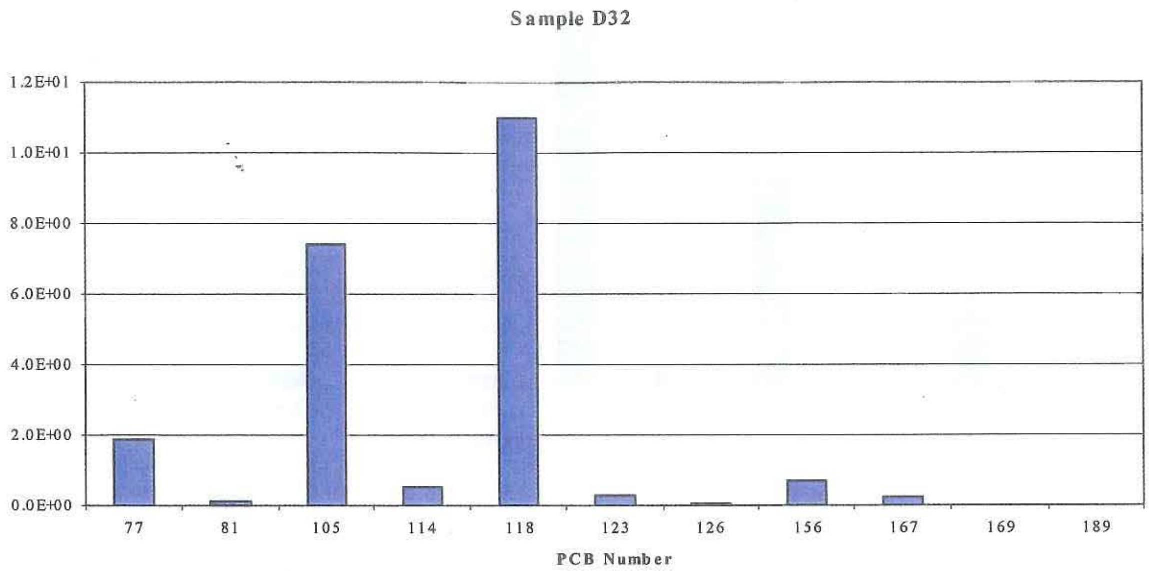


EXHIBIT A-51

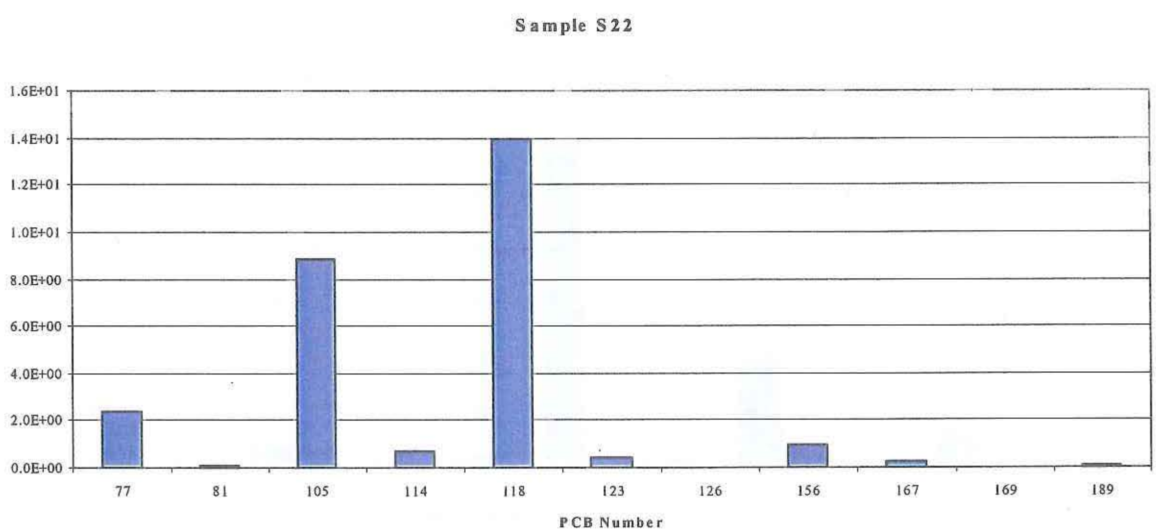


EXHIBIT A-52

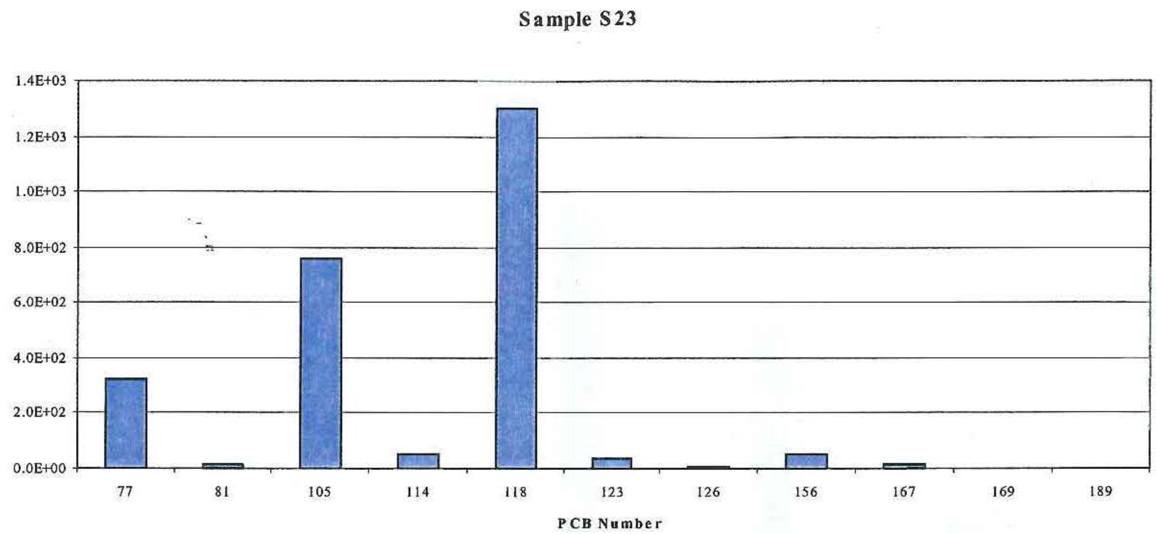


EXHIBIT A-53

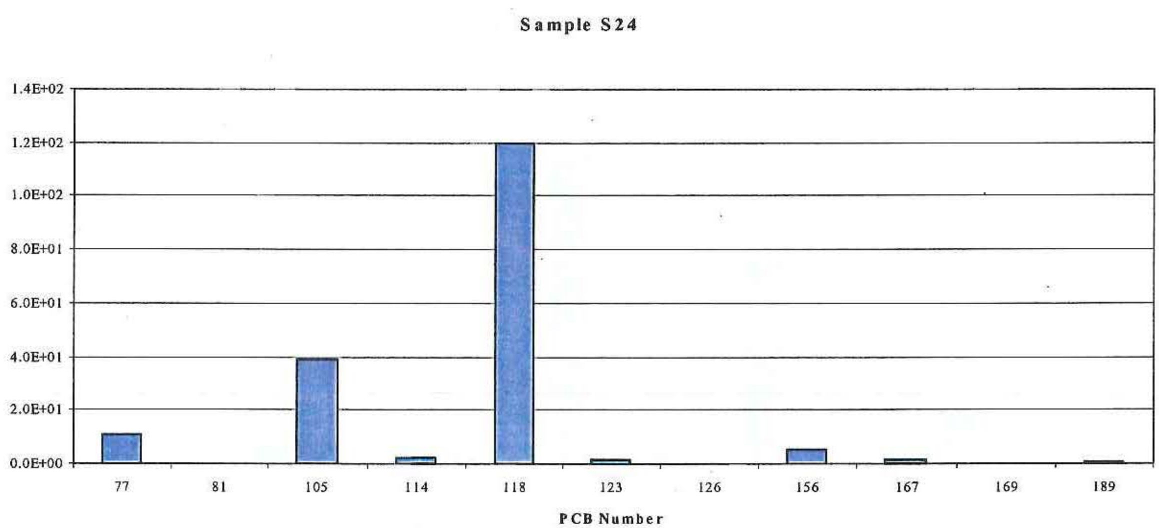


EXHIBIT A-54

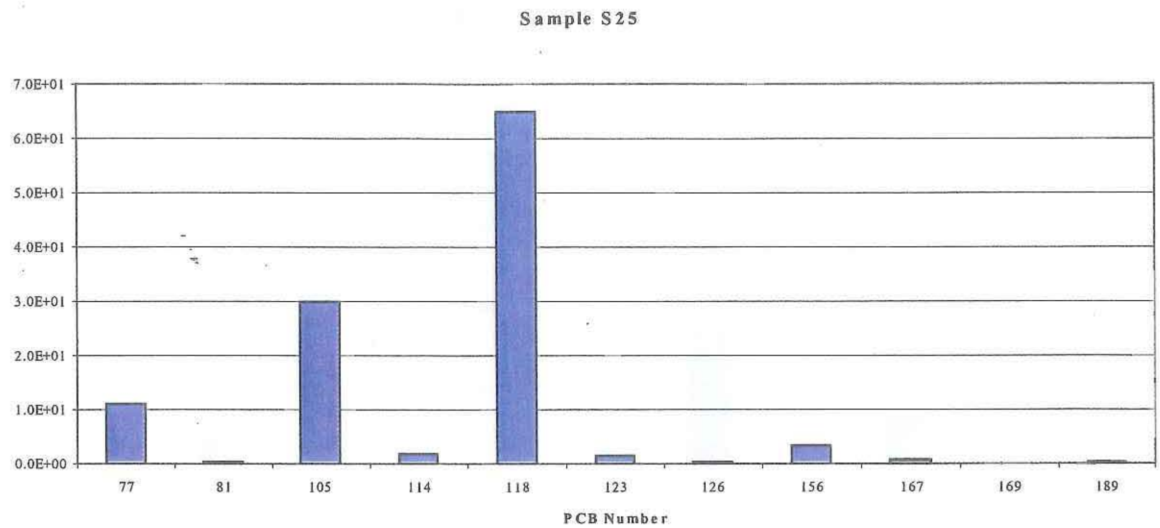


EXHIBIT A-55

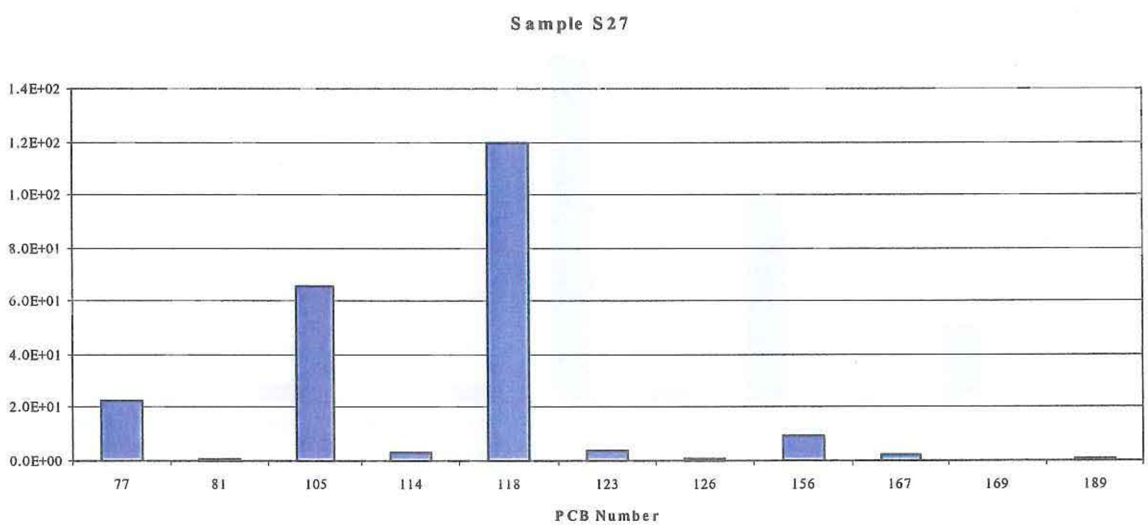


EXHIBIT A-56

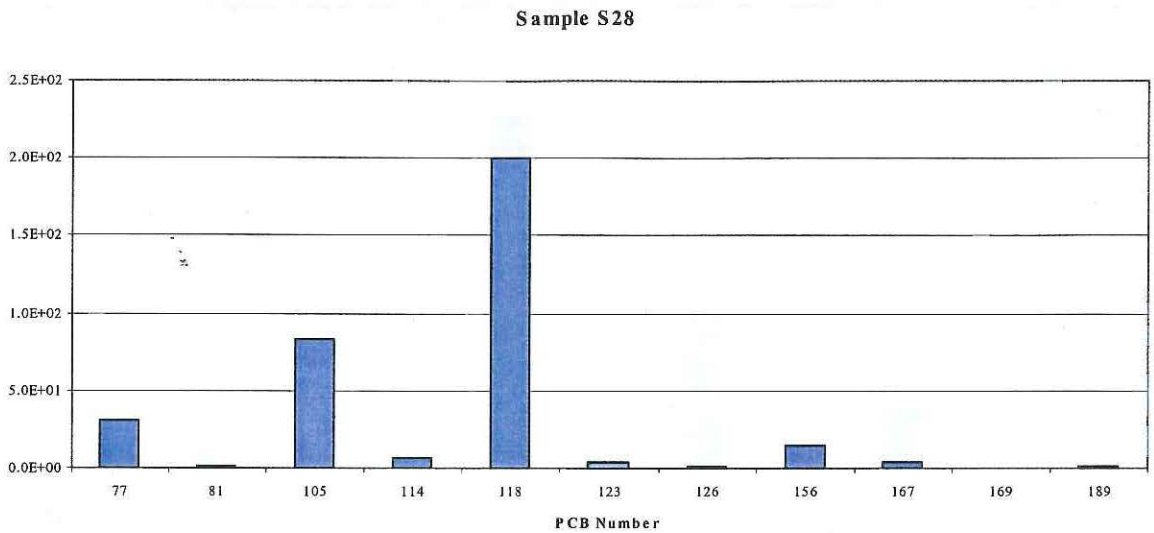


EXHIBIT A-57

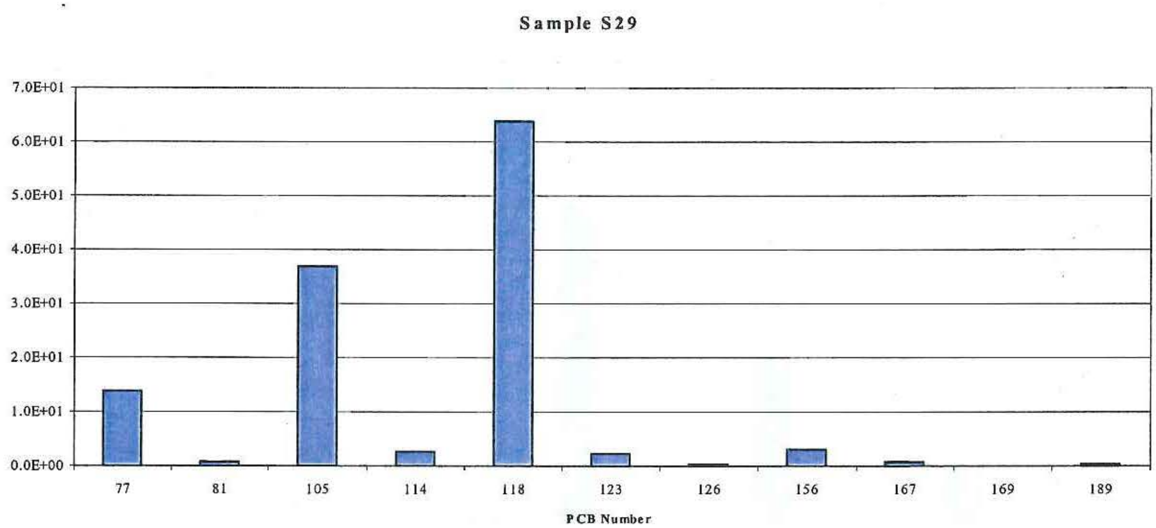


EXHIBIT A-58

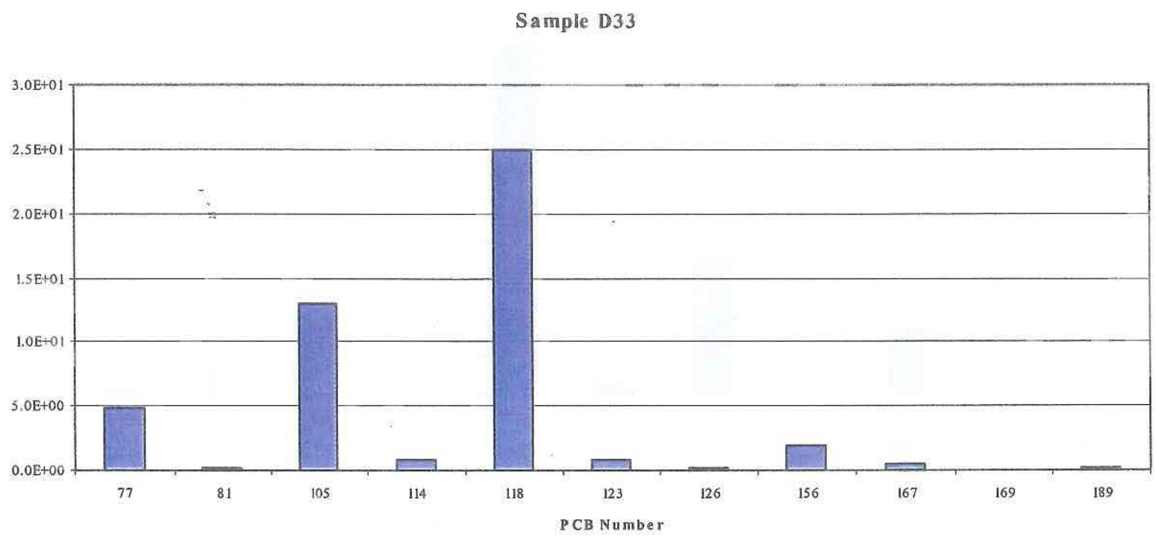


EXHIBIT A-59

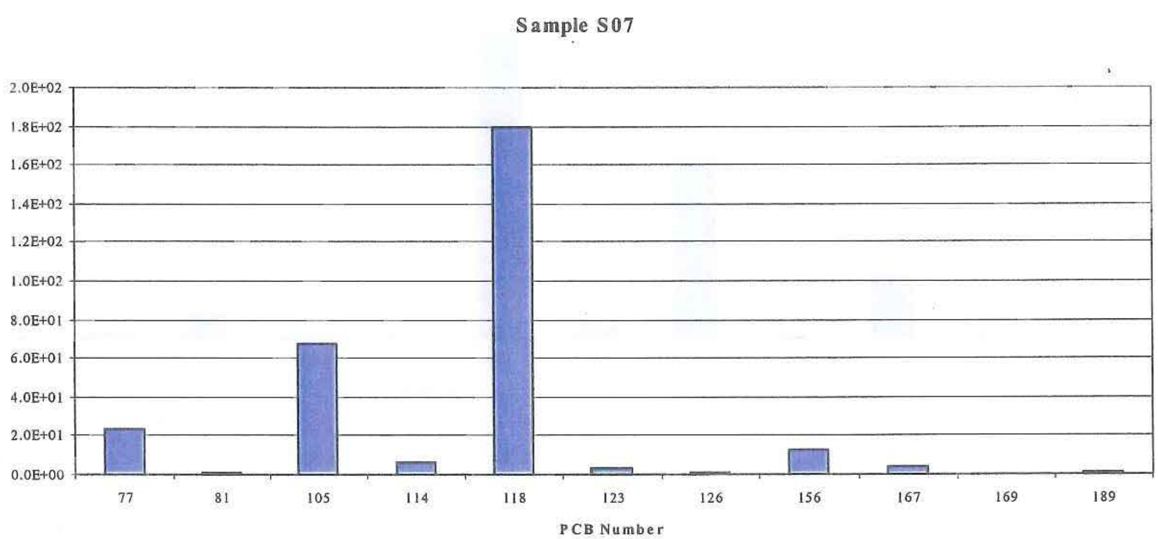


EXHIBIT A-60

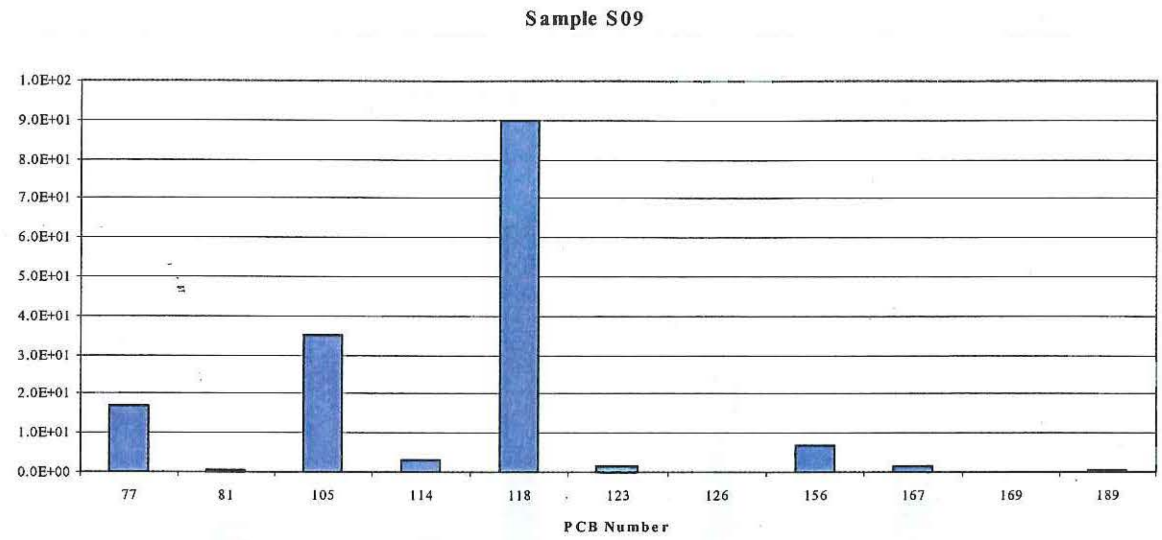


EXHIBIT A-61

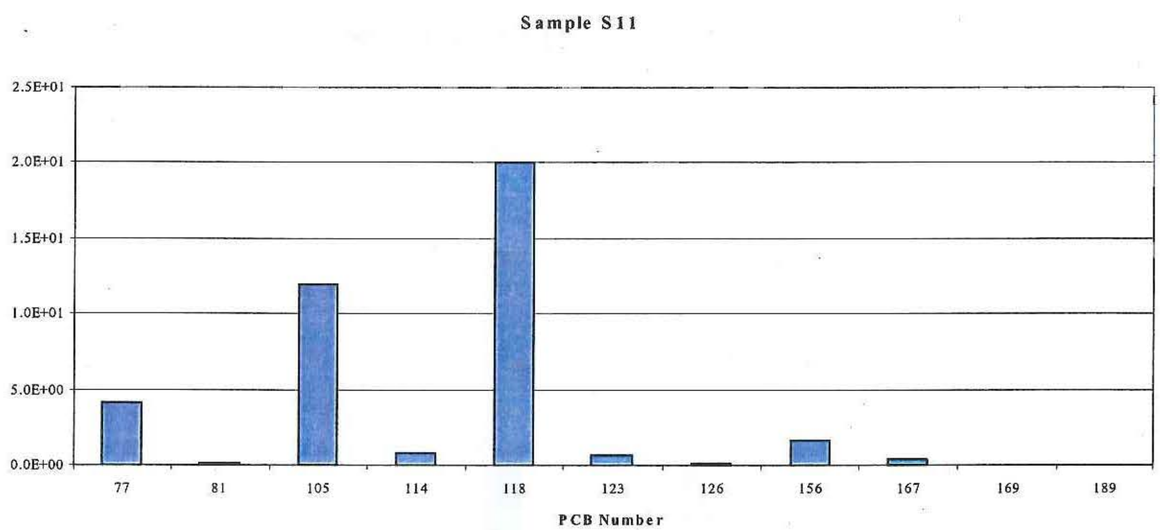


EXHIBIT A-62

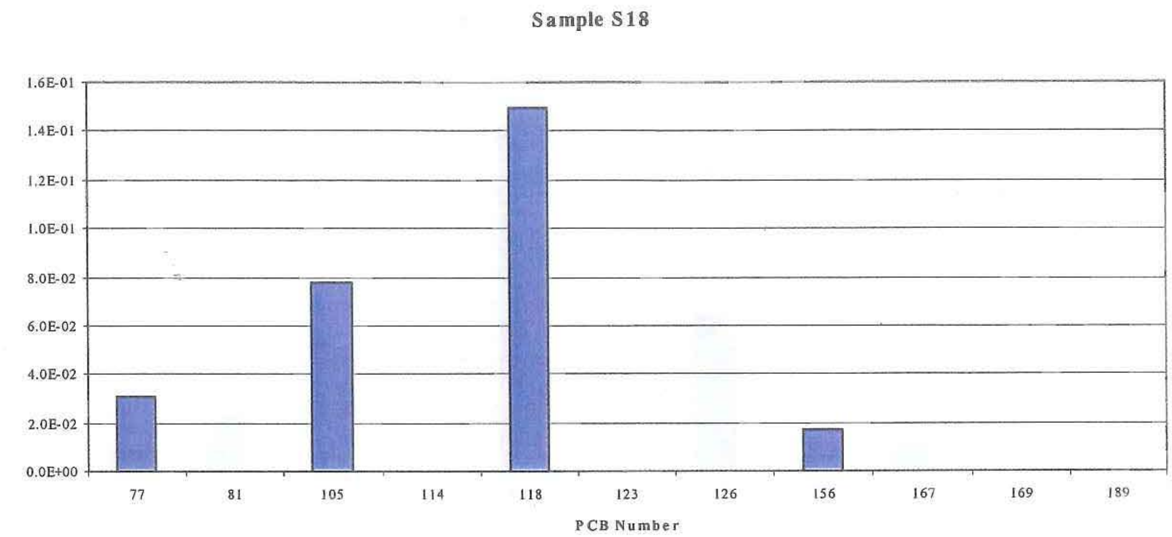


EXHIBIT A-63

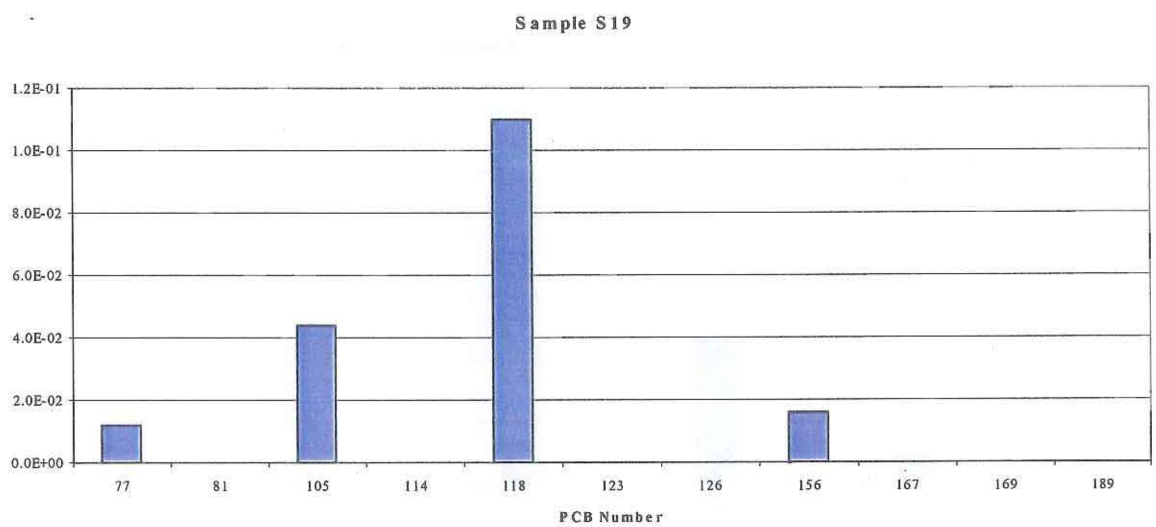


EXHIBIT A-64

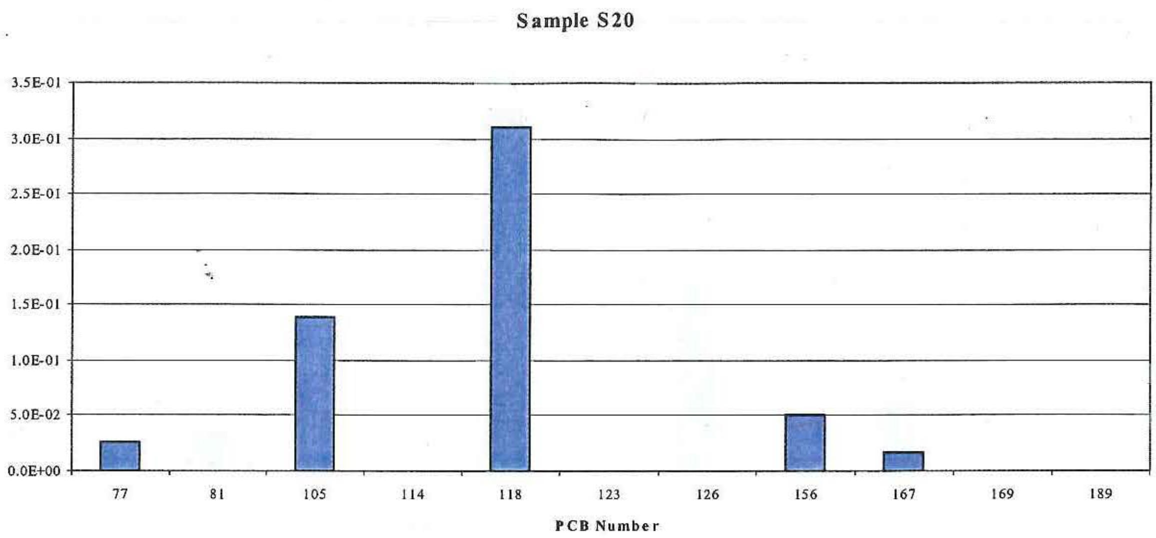


EXHIBIT A-65

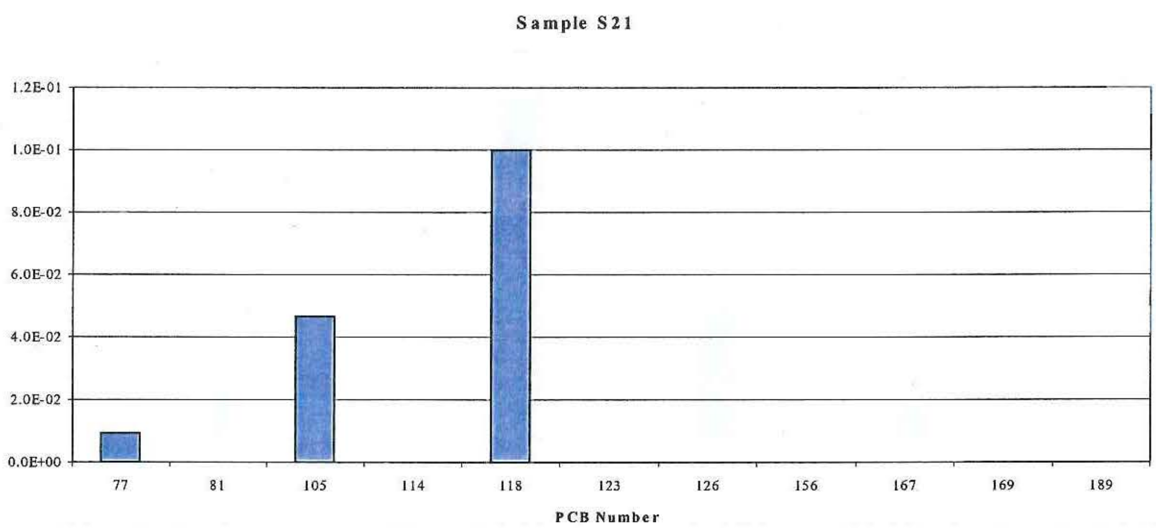


EXHIBIT A-66

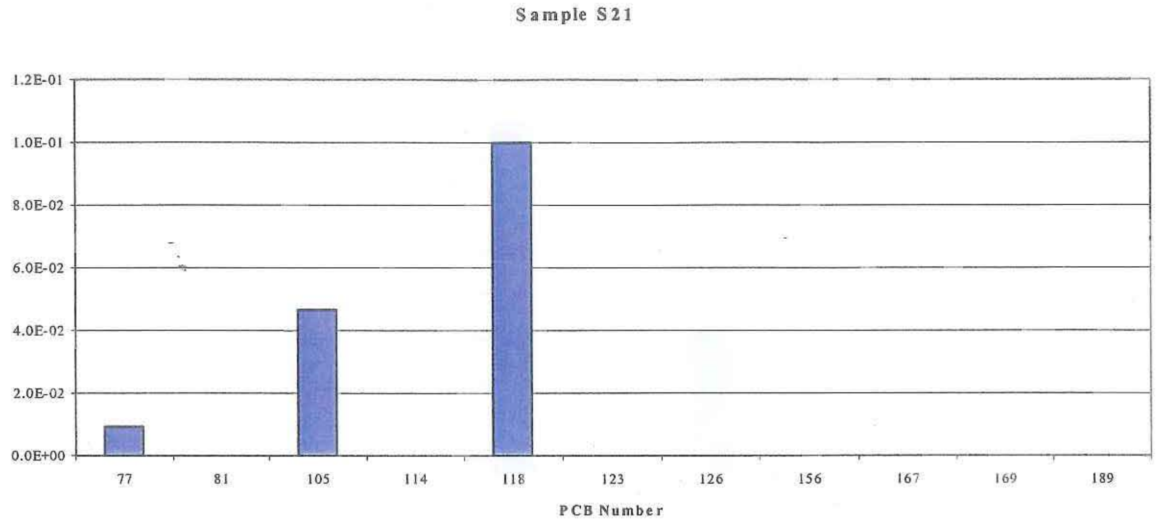


EXHIBIT A-67

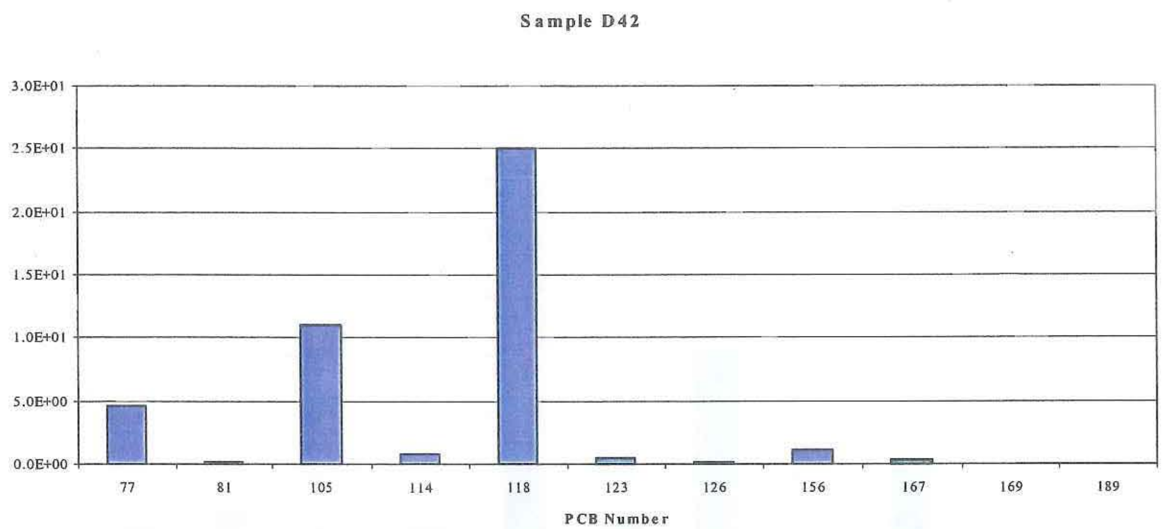


EXHIBIT A-68

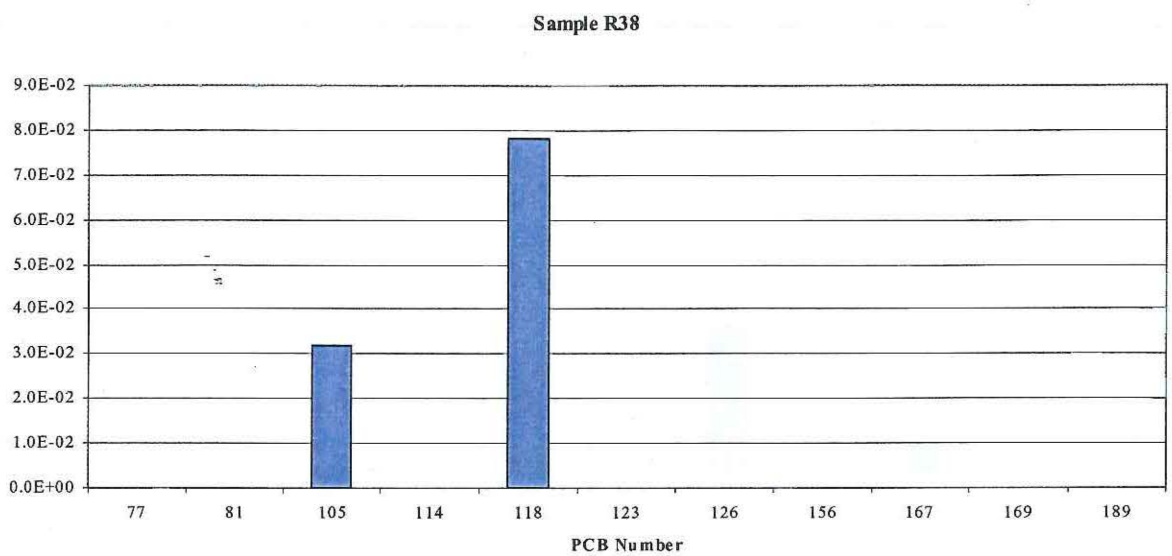


EXHIBIT A-69

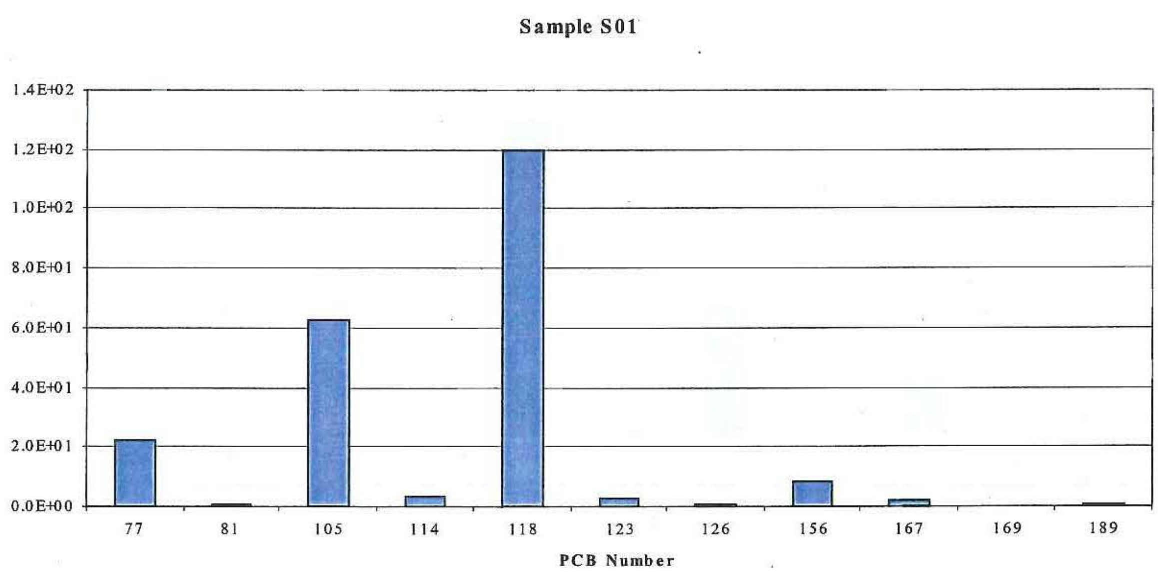


EXHIBIT A-70

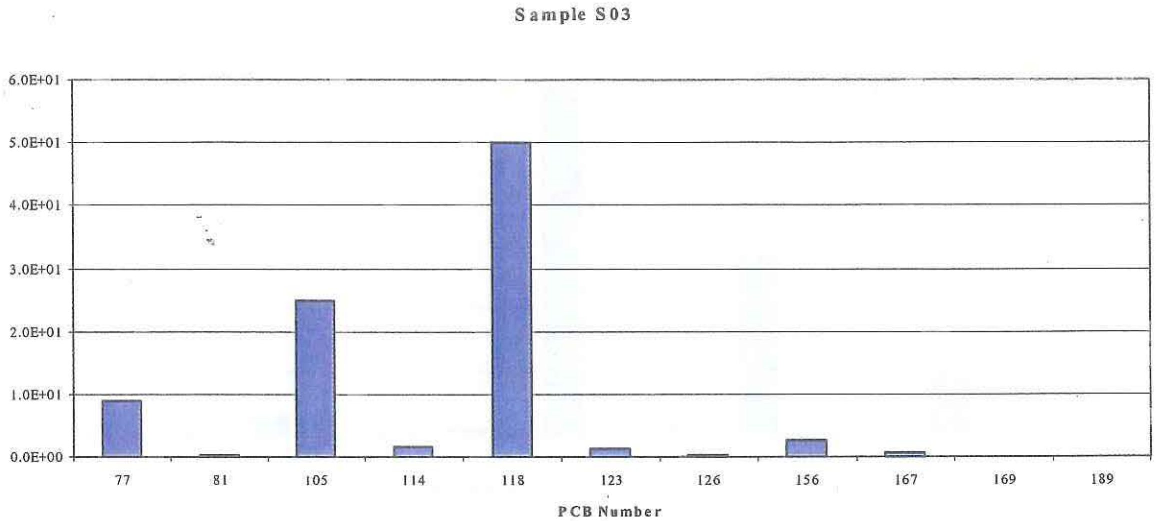


EXHIBIT A-71

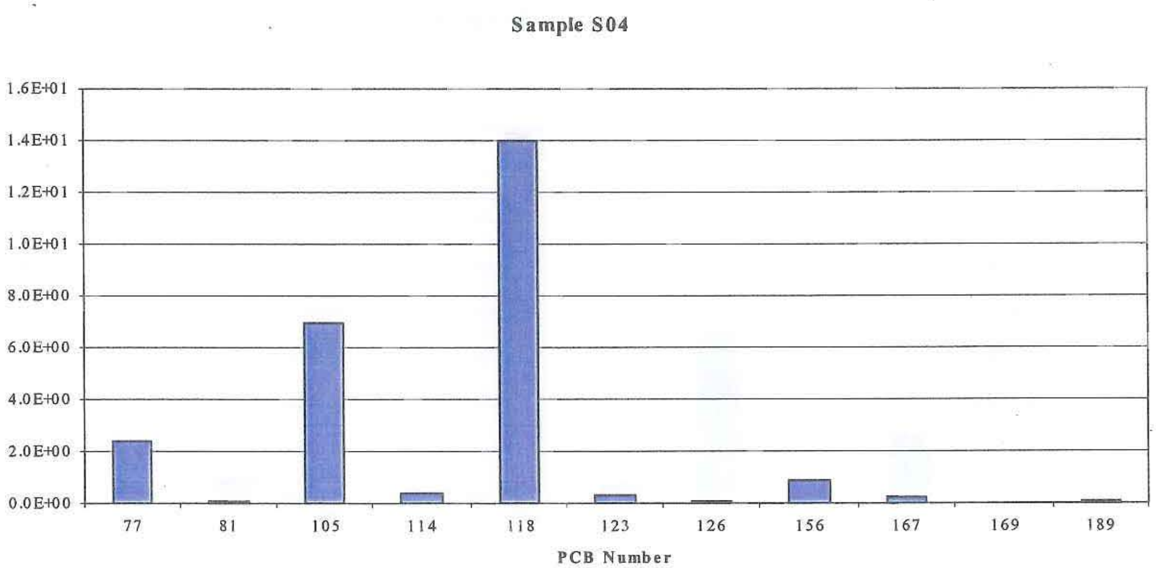


EXHIBIT A-72

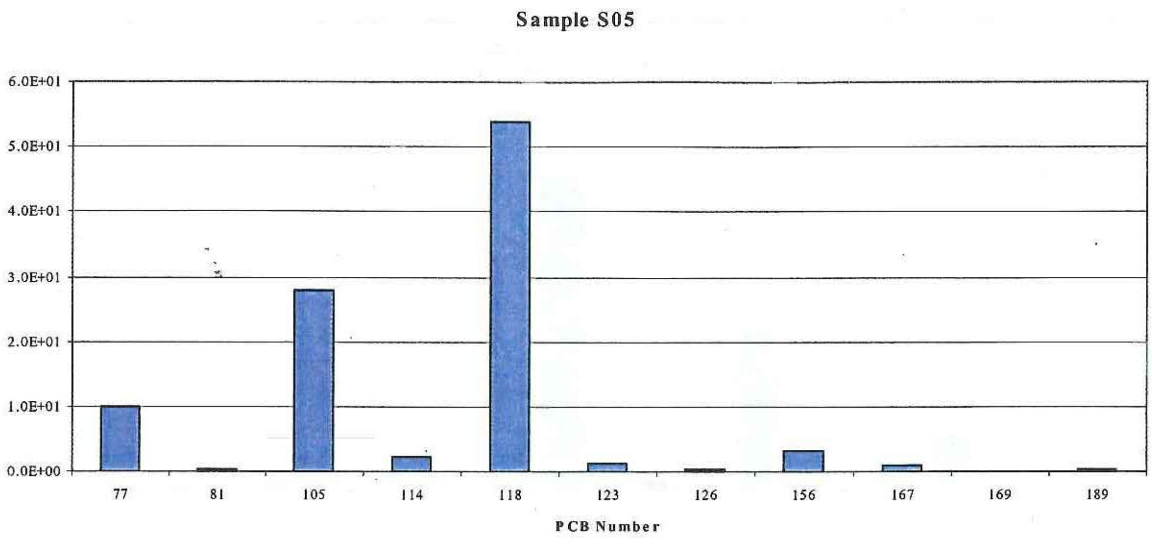


EXHIBIT A-73

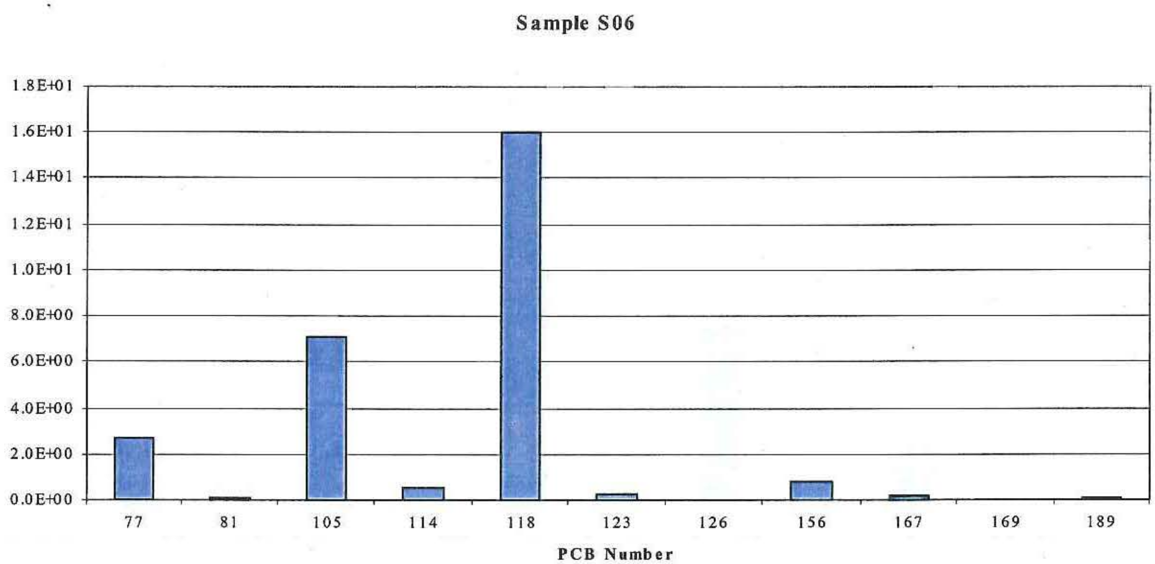


EXHIBIT A-74

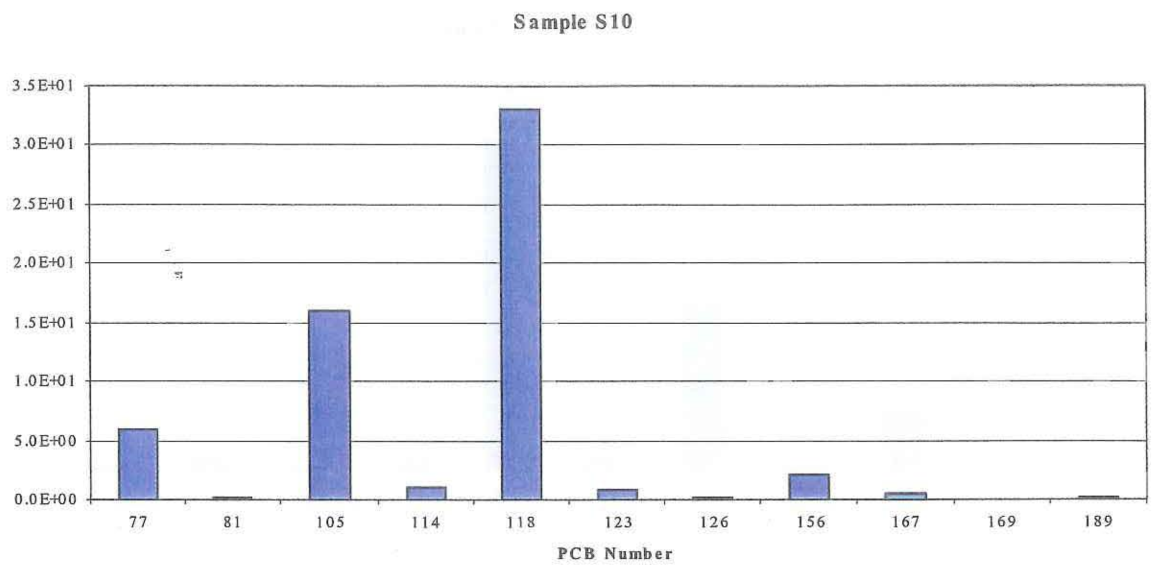


EXHIBIT A-75

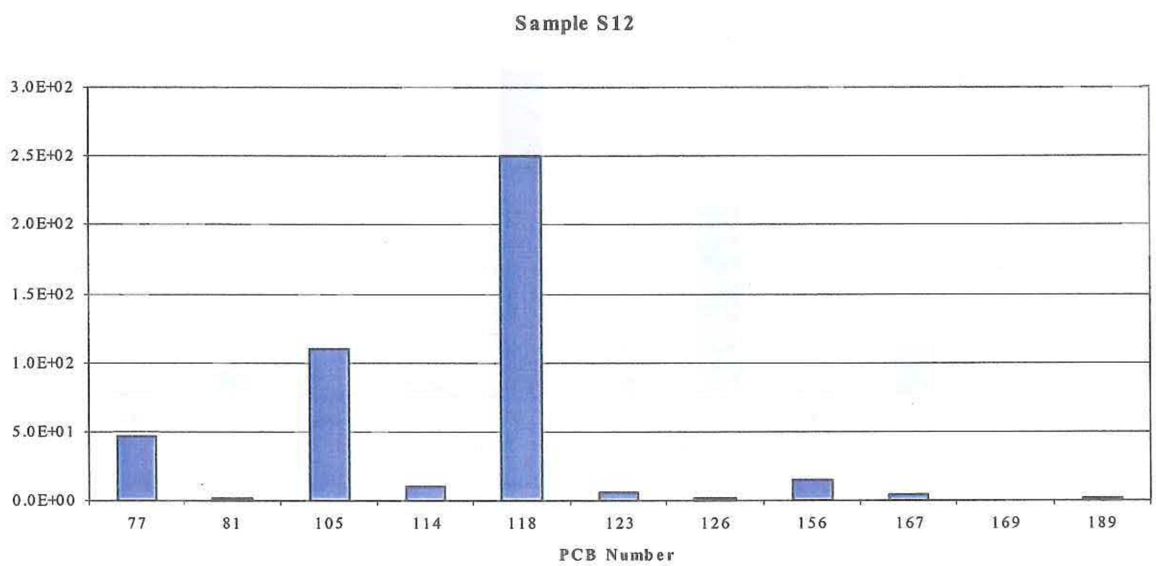


EXHIBIT A-76

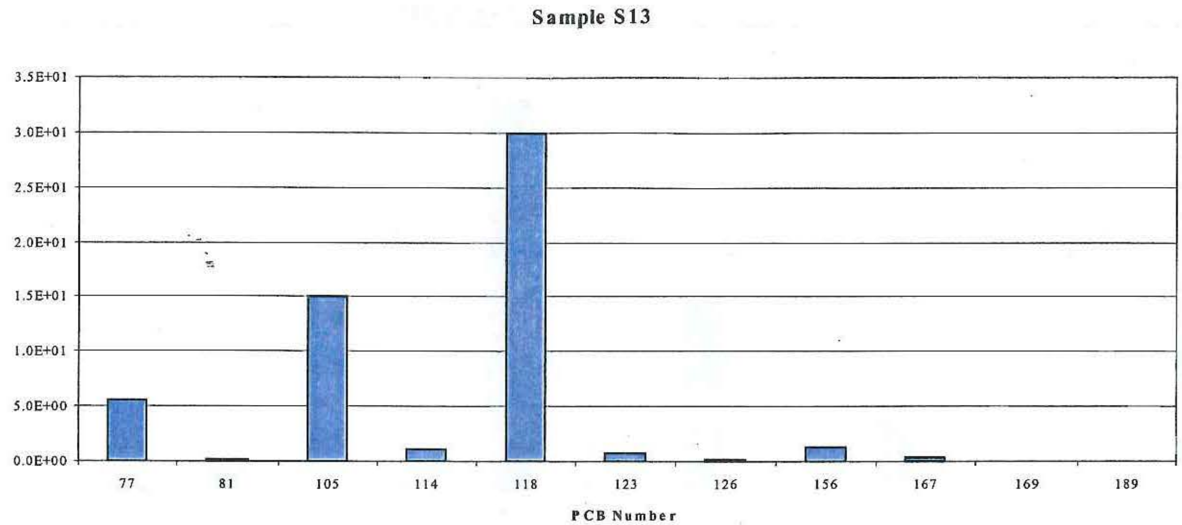


EXHIBIT A-77

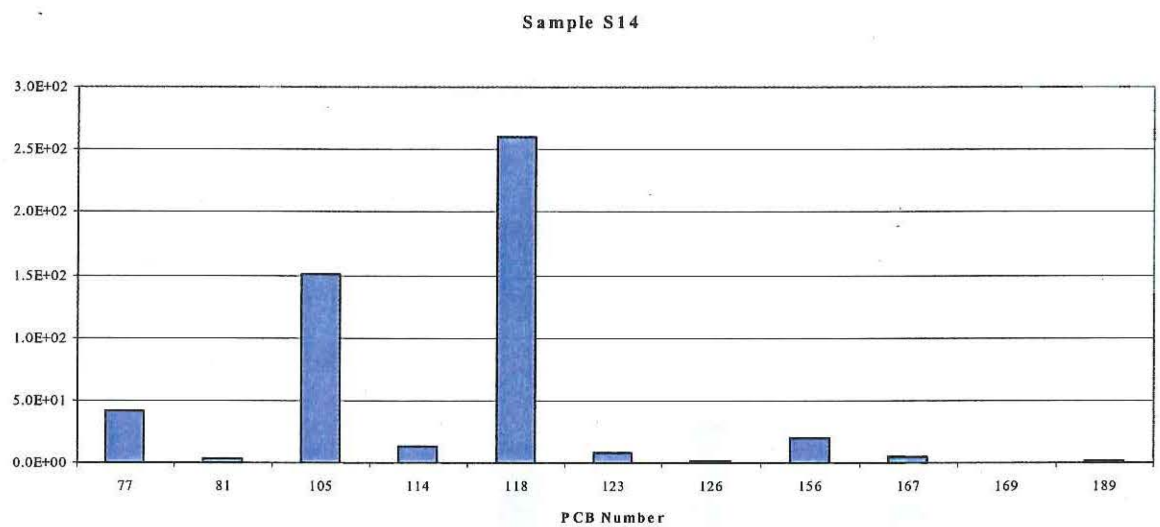


EXHIBIT A-78

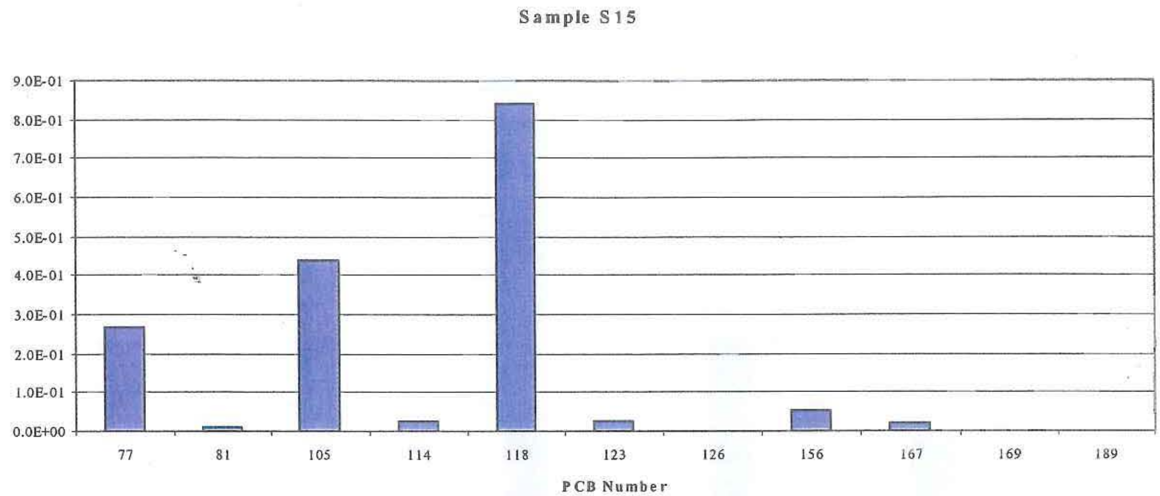


EXHIBIT A-79

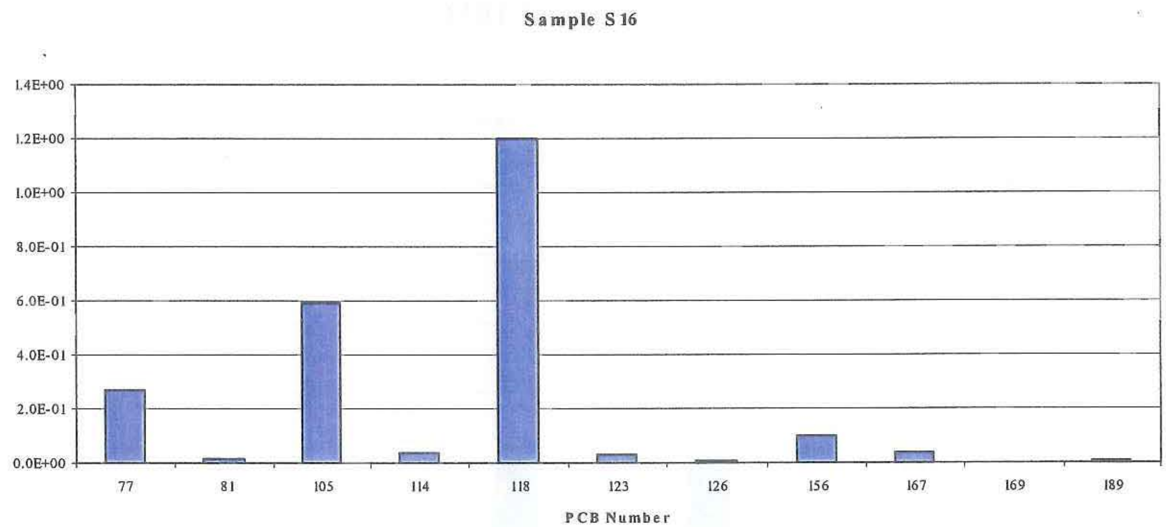


EXHIBIT A-80

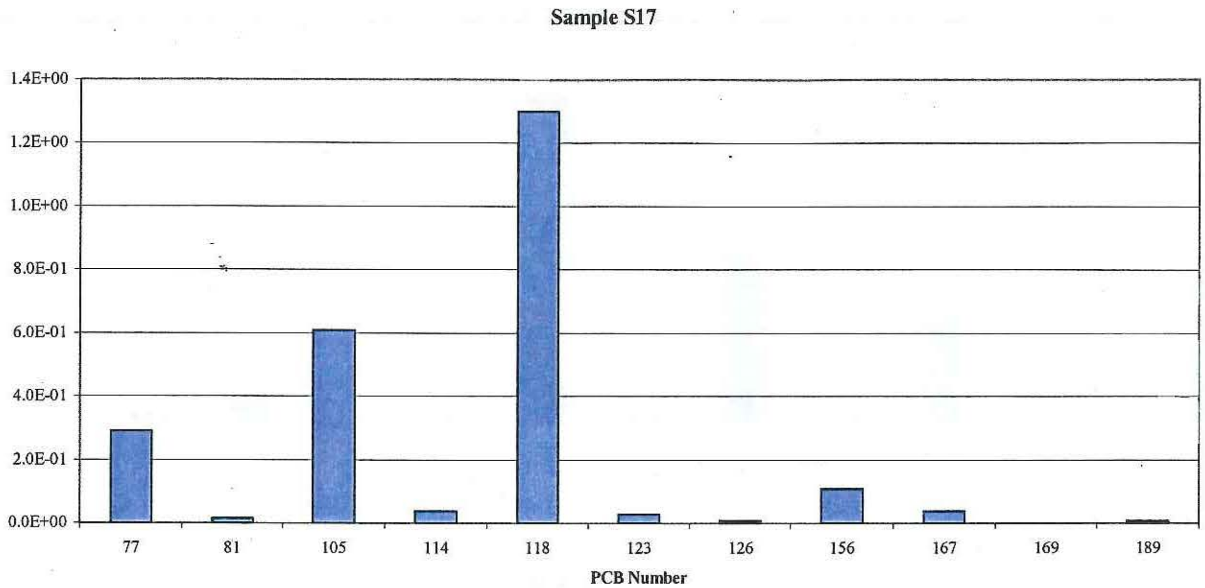


EXHIBIT A-81

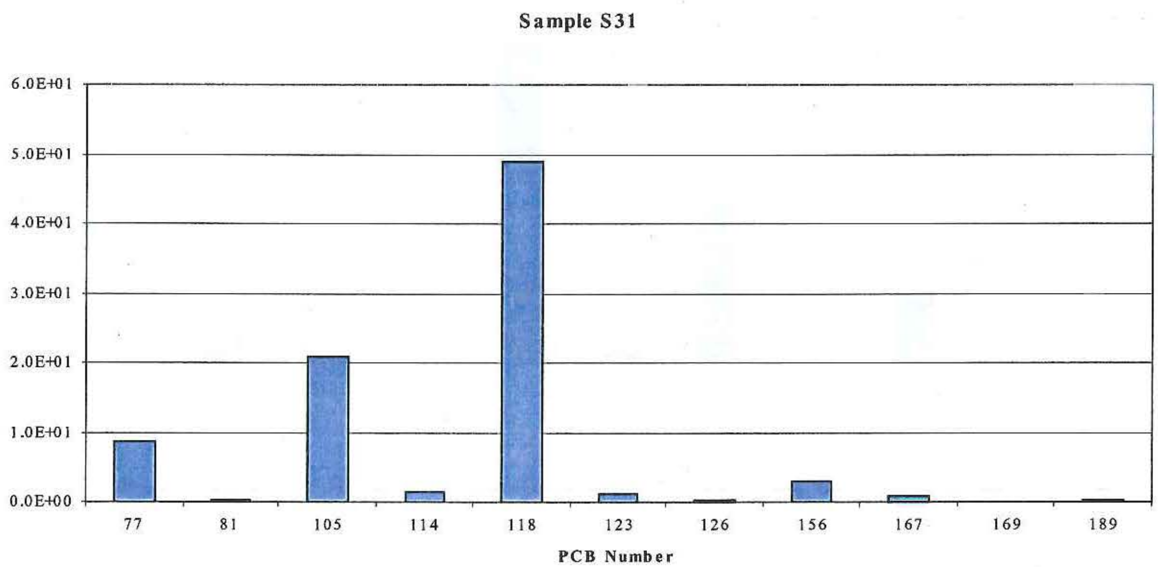
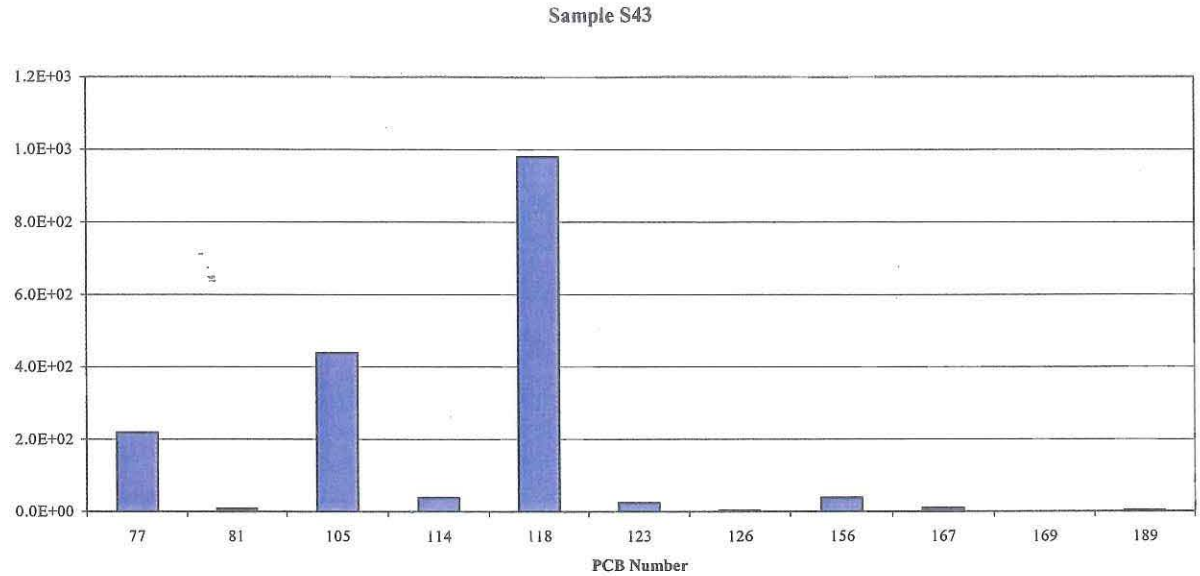


EXHIBIT A-82



These histograms clearly show that the PCB profiles in the contaminated areas are significantly different from the upstream background area.

CONCLUSIONS

This forensic fingerprint analysis conducted for dioxin-like PCBs and dioxins and furans was conducted to determine: 1) if the fingerprint for background and contaminant sediments are different indicating the contaminants in dick's creek are different from anthropogenic background conditions, and 2) if there are any third-party sources of releases in the contaminated area. The results and conclusions are unequivocal. The PCB contamination in Dick's Creek is significantly different from anthropogenic background sediments. Background conditions are typically random and without structure within the PCB mixtures because the composition of background is the result of numerous different PCB sources. In contrast PCBs from a single source are very homogeneous and structured because samples share the same original PCB composition and will weather in a similar manner.

With regard to dioxin and furan contamination the results are not as clear as to the contribution of AK Steel releases to contaminated sediments. However, the contaminated sediments do appear to be more structured than the background area.

This forensic fingerprinting approach was highly sensitive to outliers that may represent third party releases. In the background sediments there were no outliers identified. However, in the contaminated sediments, S30 is an obvious outlier . Based on this exhaustive analysis it is clear that there is only source of PCBs in Dick's Creek and Monroe Ditch and it's source is AK Steel. This is unequivocal since the PCB fingerprint in Monroe Ditch (which can only be attributed to the AK Steel property is identical to the fingerprints in all samples downstream in Dick's Creek.

The conclusions can be summarized as:

There is only one PCB congener fingerprint in contaminated sediments and flood plain soils downstream from sample location S17;

The PCB fingerprint in contaminated sediments is unique and highly structured with very strong correlations between nearly every pair, with some pairs of congeners perfectly correlated;

The PCB fingerprint for samples collected in Monroe Ditch-which can only be attributed to AK Steel-is identical to the fingerprint in all other downstream contaminated sediment sample-indicating AK Steel is responsible for all PCB contamination to at least the S30 sample location;

Unlike the AK Steel AOC PCB fingerprint, each background sample displays a different and random fingerprint which is typical in anthropogenic background conditions that do not have a single defined source but may be randomly deposited via resuspended particles and global deposition, that is the background fingerprints differ in each sample;

The only sample in the AK Steel AOC data set which was clearly identified as an anomalous sample in the PCB congener data set that indicates a potential "third party release" is sample s30 which is located miles downstream and it may represent a release from the Simpson Paper Mill, all other sample fingerprints showed remarkable similarities rarely seen with environmental PCB mixtures that have undergone extensive weathering.

APPENDIX B

EXPOSURE PARAMETERS USED TO ESTIMATE CONTAMINANT INTAKE (CHEMICAL DOSE)

EXHIBIT B-1

EXPOSURE PARAMETERS USED TO ESTIMATE CONTAMINANT INTAKE (CHEMICAL DOSE)

CHILD RECREATIONAL RECEPTOR (AGED 0 TO 6)

EXPOSURE MEDIUM: SEDIMENT
RECEPTOR: CHILD RECREATIONAL RECEPTOR

EXPOSURE ROUTE	PARAMETER CODE	RME	CTE	EXPOSURE EQUATION
INGESTION	IR (MG/DAY)	200	100	EXPOSURE=C*IR*AO*EF*ED*CF*FI*(1/BW)*(1/ATC)
	AO (UNITLESS)	1	1	
	EF (DAYS/YEAR)	89	47	
	ED (YEARS)	6	2	
	CF (KG/MG)	1.00E-06	1.00E-06	
	FI (UNITLESS)	1	1	
	BW (KG)	15	15	
	ATC (DAYS)	25,550	25,,550	
	ATNC (DAYS)	2,190	730	
DERMAL	SA (CM2)	894	498	EXPOSURE =SA*AF*EF*ED*CF*ABS*(1/BW)*(1/ATC)
	AF (MG/CM2-DAY)	0.3	0.3	
	EF (DAYS/YEAR)	89	47	
	ED (YEARS)	6	2	
	CF (KG/MG)	1.00E-06	1.00E-06	
	BW (KG)	15	15	
	ABS	0.14	0.14	
	ATC (DAYS)	25,550	25,550	
	ATNC (DAYS)	2,190	730	

Note: Chemical Intake (Average Daily Dose or Lifetime Average Daily Dose) = Exposure Point Concentration * Exposure

EXHIBIT B-2

EXPOSURE PARAMETERS USED TO ESTIMATE CONTAMINANT INTAKE (CHEMICAL DOSE)

ADULT RECREATIONAL RECEPTOR

EXPOSURE MEDIUM: SEDIMENT RECEPTOR: ADULT RECREATIONAL RECEPTOR

EXPOSURE ROUTE	PARAMETER CODE	RME	CTE	EXPOSURE EQUATION
INGESTION	IR (MG/DAY)	100	50	EXPOSURE =IR*AO*EF*ED*CF*FI*(1/BW)*(1/ATC)
	AO (UNITLESS)	1	1	
	EF (DAYS/YEAR)	89	47	
	ED (YEARS)	24	7	
	CF (KG/MG)	1.00E-06	1.00E-06	
	FI (UNITLESS)	1	0.5	
	BW (KG)	70	70	
	ATC (DAYS)	25,550	25,550	
	ATNC (DAYS)	8,760	2,555	
DERMAL	SA (CM2)	1,841	1,050	EXPOSURE =SA*AF*EF*ED*CF*ABS*(1/BW)*(1/ATC)
	AF (MG/CM2-DAY)	0.3	0.3	
	EF (DAYS/YEAR)	89	47	
	ED (YEARS)	24	7	
	CF (KG/MG)	1.00E-06	1.00E-06	
	BW (KG)	70	70	
	ABS	0.14	0.14	
	ATC (DAYS)	25,550	25,550	
	ATNC (DAYS)	8,760	2,555	

Note: Chemical Intake (Average Daily Dose or Lifetime Average Daily Dose) = Exposure Point Concentration * Exposure

EXHIBIT B-3

EXPOSURE PARAMETERS USED TO ESTIMATE CONTAMINANT INTAKE (CHEMICAL DOSE)
CHILD FISH INGESTION (AGED 0 TO 6)

EXPOSURE MEDIUM: FISH
RECEPTOR: CHILD

EXPOSURE ROUTE	PARAMETER CODE	RME	CTE	EXPOSURE EQUATION
INGESTION	CR (G/DAY)	9	5.4	EXPOSURE =CR*EF*ED*CF*FI*(1/BW)*(1/ATC)
	EF (DAYS/YEAR)	365	365	
	ED (YEARS)	6	2	
	CF (KG/G)	1.00E-03	1.00E-03	
	FI (UNITLESS)	0.5	0.05	
	BW (KG)	15	15	
	ATC (DAYS)	25,550	25,550	
	ATNC (DAYS)	2,190	730	

Note: Chemical Intake (Average Daily Dose or Lifetime Average Daily Dose) = Exposure Point Concentration * Exposure

EXHIBIT B-4

EXPOSURE PARAMETERS USED TO ESTIMATE CONTAMINANT INTAKE (CHEMICAL DOSE)

ADULT FISH INGESTION

EXPOSURE MEDIUM: FISH RECEPTOR: ADULT

EXPOSURE ROUTE	PARAMETER CODE	RME	CTE	EXPOSURE EQUATION
INGESTION	CR (G/DAY), C	18	9	EXPOSURE =CR*EF*ED*CF*FI*(1/BW)*(1/ATC)
	EF (DAYS/YEAR)	365	365	
	ED (YEARS)	24	7	
	CF (KG/G)	1.00E-03	1.00E-03	
	FI (UNITLESS)	0.5	0.5	
	BW (KG), P	70	70	
	ATC (DAYS)	25,550	25,550	
	ATNC (DAYS)	8,760	2,555	

Note: Chemical Intake (Average Daily Dose or Lifetime Average Daily Dose) = Exposure Point Concentration * Exposure

NOTES ON EXPOSURE PARAMETER VALUES
HUMAN HEALTH RISK ASSESSMENT
AK STEEL FACILITY, MIDDLETOWN, OHIO

USEPA. 1997. EXPOSURE FACTORS HANDBOOK. EPA/600/P-95/002Fa August 1997.

USEPA. 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories Volume 1 Fish Sampling and Analysis, Third Edition (EPA 823-B-00-007 2000)

Incidental ingestion rates are based on EPA (1997).

All surface areas are from EPA 1997, Volume I, Tables 6-4 through 6-8.

Chemical-specific absorption factor; 0.14 was used for dermal absorption of PCBs

The averaging time for noncarcinogens reflects the exposure durations of 2, 6, 7, and 24 years: 2 years x 365 days/year = 730 days; 6 years x 365 days/year = 2190 days; 7 years x 365 days/year = 2555 days; 24 years x 365 days/year = 25,550 days.